The Ordovician graptolites of the Shelve District, Shropshire

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Synopsis

The distribution of graptolites in the Ordovician of the Shelve area is recorded, based largely on the collections made for the late Professor W. F. Whittard in the 1950s and 1960s while he was mapping the area and monographing the trilobites. This is the first illustrated account of the comparatively poor graptolite faunas. Some 60 species are here described but no new names are proposed. A lectotype of *Leptograptus latus* Elles & Wood 1903 is selected. Almost every species requires critical re-examination of types (almost entirely from other areas) and population studies which cannot be done on the existing material.

The Ordovician of Shelve, from Arenig to basal Caradoc, is probably the most complete for this span of time in the British Isles and with this contribution the macrofauna is largely described, so that detailed comparison with other areas is now possible.

Introduction

Graptolites were first recorded from the Shelve Inlier in Murchison's *Silurian System* (1839), in which he described the new species *Graptolithus foliaceus* from the Meadowtown beds. Subsequent records have been sporadic and although there were further records in the 19th century there was no description of specimens from Shelve until the first part of Elles & Wood's monograph in 1901. Morton (1877), Lapworth (1879, 1887) and particularly Lapworth & Watts (1894) provided some species names associated with a few localities, and by 1890 Lapworth had certainly collected fairly systematically from the most fossiliferous levels. The Shelve Church Beds were well known by 1875 for the abundance of dendroids to be found there. With the publication of the first few parts of Elles & Wood's monograph, illustrations of Shelve species appeared in some numbers and in the text there were further records of the species to be found in the inlier. In 1892, Lapworth had managed to persuade the Geological Survey to let John Rhodes collect from selected horizons in both the Shelve and Caradoc/Wrekin areas so that representative Cambrian and Ordovician faunas could be assembled; a second collecting foray, this time by Manson, was undertaken in 1914. Lapworth provided a report based on these, and vertical sections of the strata, in 1916. There are few additional records of graptolites in the later accounts (summarized by Whittard, 1931) and it was generally assumed that the lithological sequence proposed by Lapworth was well known and dated. When, in the early 1950s, Whittard found that in places the stratigraphy was more complicated than shown on the small-scale map of Lapworth & Watts (1894), he wanted someone to identify the graptolites, as they were found, to tie his trilobite work into the standard succession of zones. At O. M .B. Bulman's suggestion, I undertook this task in 1955 and at various times during the next ten years I had parcels of specimens, with only locality numbers, to identify. One of the first surprises was the recognition that the highest beds in the inlier were much lower stratigraphically than had been previously suggested. With Whittard's sudden death in 1966, the Shelve material was left until the stratigraphical framework had been published (Whittard, ed. Dean 1979), but in the meantime there had been a very great increase in worldwide publications on Ordovician graptolites, particularly in Russia and latterly in China. It has not been possible to re-examine all the Whittard Collection but representative specimens from different horizons and localities have been restudied. With the trilobites (Whittard 1955–67) and the brachiopods (Williams 1974) now monographed and the map (Whittard, ed. Dean 1979) available, the third main group of fossils is illustrated here.

The graptolites are found in a wide variety of lithologies, from black micaceous silty shales to impure sandy limestones and volcanic ashes. They are only rarely found as the silvery films characteristic of true graptolitic shales and photography of black specimens on dark rocks has proved difficult. In the Rorrington and Aldress Members, which are the richest in variety of forms, the graptolites are frequently pyritized but retain their black skeleton. Weathered specimens, however, can provide a good colour contrast for photography. Line drawings have been made of specimens which it was impossible to photograph satisfactorily. The plates have been arranged stratigraphically so that a general view of the faunas at different horizons can be easily obtained.

Table 1 Stratigraphical distribution of species arranged in order of appearance.

	Mytton	Hope	Stapeley	Weston	Betton	Meadowtown	Rorrington	Spy Wood	Aldress	Hagley	Whittery
Clonograptus sp.	+	–	–	–	–	–	–	–	–	–	–
Tetragraptus cf. *bigsbyi*	+	–	–	–	–	–	–	–	–	–	–
?*Tetragraptus* sp.	+	–	–	–	–	–	–	–	–	–	–
Expansograptus cf. *hirundo*	+	–	–	–	–	–	–	–	–	–	–
E. cf. *nitidus*	+	–	–	–	–	–	–	–	–	–	–
E. cf. *praenuntius*	+	–	–	–	–	–	–	–	–	–	–
E. cf. *simulans*	+	–	–	–	–	–	–	–	–	–	–
E. cf. *sparsus*	+	–	–	–	–	–	–	–	–	–	–
E. cf. *suecicus*	+	–	–	–	–	–	–	–	–	–	–
Corymbograptus deflexus	+	–	–	–	–	–	–	–	–	–	–
C. cf. *inflexus*	+	–	–	–	–	–	–	–	–	–	–
Isograptus sp.	?	–	–	–	–	–	–	–	–	–	–
Glyptograptus dentatus	?	+	–	–	–	–	–	–	–	–	–
G. shelvensis	+	–	–	–	–	–	–	–	–	–	–
Pseudophyllograptus cf. *angustifolius*	–	+	–	–	–	–	–	–	–	–	–
P.(?) cf. *glossograptoides*	–	+	–	–	–	–	–	–	–	–	–
Didymograptus pluto	–	+	+	–	–	–	–	–	–	–	–
D. cf. *stabilis*	–	+	+	–	+	–	–	–	–	–	–
Expansograptus cf. *euodus*	–	+	–	–	–	–	–	–	–	–	–
Acrograptus acutidens	–	+	–	–	–	–	–	–	–	–	–
A. gracilis	–	+	–	–	–	–	–	–	–	–	–
Glossograptus cf. *armatus*	–	+	–	–	–	–	–	–	–	–	–
Amplexograptus cf. *confertus*	–	?	?	–	–	–	–	–	–	–	–
Glyptograptus sp.	–	+	–	–	–	–	–	–	–	–	–
Didymograptus aff. *miserabilis*	–	–	+	–	+	–	–	–	–	–	–
Glossograptus cf. *acanthus*	–	–	+	–	–	–	–	–	–	–	–
G. fimbriatus	–	–	+	–	–	–	–	–	–	–	–
Didymograptus murchisoni	–	–	–	+	+	–	–	–	–	–	–
Gymnograptus (?) sp.	–	–	–	–	+	–	–	–	–	–	–
Cryptograptus schaeferi	–	–	–	–	–	+	–	–	–	–	–
Dicellograptus divaricatus	–	–	–	–	–	+	+	–	–	–	–
D. sextans	–	–	–	–	–	?	+	–	–	–	–
D. cf. *vagus*	–	–	–	–	–	+	–	–	–	–	–
Dicranograptus irregularis	–	–	–	–	–	+	–	–	–	–	–
D. sp.	–	–	–	–	–	+	–	–	–	–	–
Diplograptus foliaceus	–	–	–	–	–	+	–	–	+	+	+
Climacograptus aff. *antiquus lineatus*	–	–	–	–	–	+	+	–	+	+	–
Nemagraptus gracilis	–	–	–	–	–	–	+	–	–	–	–
N. gracilis cf. *distans*	–	–	–	–	–	–	+	–	–	–	–
Leptograptus validus	–	–	–	–	–	–	+	–	–	–	–
L. latus	–	–	–	–	–	–	+	–	–	–	–
Dicellograptus intortus	–	–	–	–	–	–	+	+	–	–	–
D. salopiensis	–	–	–	–	–	–	+	–	–	–	–
D. exilis	–	–	–	–	–	–	+	+	–	–	–
Dicranograptus brevicaulis	–	–	–	–	–	–	+	–	–	–	–
D. rectus	–	–	–	–	–	–	+	+	–	–	–
Diplograptus leptotheca	–	–	–	–	–	–	+	–	+	+	+
Glyptograptus teretiusculus	–	–	–	–	–	–	+	–	–	–	–
Orthograptus uplandicus	–	–	–	–	–	–	+	+	–	–	–

Table continued over

Table 1 continued.

	Mytton	Hope Stapeley	Weston Betton	Meadowtown Rorrington Spy Wood			Aldress Hagley Whittery		
Climacograptus brevis	–	– –	– –	–	+	–	+	–	–
Pseudoclimacograptus modestus	–	– –	– –	–	+	–	–	–	?
Orthograptus cf. *apiculatus*	–	– –	– –	–	–	+	+	–	–
Cryptograptus tricornis	–	– –	– –	–	–	–	+	–	–
Corynoides cf. *curtus*	–	– –	– –	–	–	–	+	–	–
Diplograptus multidens	–	– –	– –	–	–	–	+	–	–
Amplexograptus fallax	–	– –	– –	–	–	–	+	–	–
Orthograptus truncatus	–	– –	– –	–	–	–	+	–	+
Climacograptus sp.	–	– –	– –	–	–	–	+	–	–
C. cf. *tubularis*	–	– –	– –	–	–	–	+	–	–
Lasiograptus costatus	–	– –	– –	–	–	–	+	–	–
Climacograptus peltifer	–	– –	– –	–	–	–	–	+	–
Pseudoclimacograptus scharenbergi	–	– –	– –	–	–	–	–	+	+

Whittard's graptolite material on which this study is based is all now preserved in the Department of Palaeontology, British Museum (Natural History); register numbers are prefixed by Q. Other material, prefixed BU, in Birmingham University Museum, GSM, in British Geological Survey, and SM, in Sedgwick Museum, Cambridge.

Faunal succession

Mytton Member. Most of the 25 localities have only one or two species present, and although some dozen species are found overall it is not possible to say more than that the fauna is Arenig in age. The most widespread species is *E. nitidus* which is found in five different localities, and in the absence of good specimens of *E. hirundo* it is most likely that the greater part of the Mytton Member should be referred to the *extensus* Zone of the old nomenclature. The status of subdivisions of this zone, as well as a critical re-examination of a *hirundo* Zone as such, needs much further collecting and study in Britain. At one time, the topmost beds of the Mytton Member were separated off as the Tankerville Flags. Bergam Quarry (Loc. 783) has yielded *E.* cf. *suecicus* as well as *E. nitidus*, which provides a link to the overlying '*bifidus*' Zone from which it has been more usually recorded. No pendent didymograptids have been found so far in the Mytton Member. Records of *E. hirundo* have almost all been of single, broad dichograptid stipes which could be tetragraptid. There is a single isograptid which occurs without associates and appears to be a new species.

Hope Member. There are some 50 localities in this unit yielding graptolites but in about half of them the specimens are fragmentary or only identifiable as *Didymograptus* sp. A problem in the first identifications of the collection was that forms referable to both *D.* '*bifidus*' and *D. murchisoni* occurred in the Hope Member. The association with *A. acutidens* and *A. gracilis*, however, strongly suggests the lower part of the Llanvirn for this member. It is unfortunate that only single specimens of the phyllograptoids have been found so that their identification is uncertain, as they might have provided some better control by comparison with Scandinavia. Not all the localities have been found in Whittard's notes and no attempt has been made to compare the faunas of beds below and above the Chinastone Ash which has been used as a field division into upper and lower parts of the member. Few localities have more than two or three recognizable species present and there is no obvious grouping of localities by fauna.

Stapeley Volcanic Member. There are only three graptolite localities in this member amongst the material which I have seen. One of these yielded *Glyptograptus* sp., another indeterminate slender dichograptid stipes and the third pendent didymograptids. The horizon cannot be more precisely placed than Llanvirn.

Stapeley Shale Member. This, as might be expected, is considerably more fossiliferous than the underlying volcanic member but few localities have more than one species present. The richest locality has *A. acutidens*, *D. pluto* and *G. fimbriatus*, which clearly puts it in the lower part of the Llanvirn. Other species which occur in the member include *D. stabilis*, *D. miserabilis* and *Amplexograptus confertus*, providing links mainly with the earlier Hope Member. Loc. 463, which has *D. miserabilis*, is close to the base of the succeeding Weston Member.

Weston Member. There are only a few graptolitic localities in this member and originally Whittard (1955: 5) put the Weston Beds in the *bifidus* Zone. The pendent didymograptids appear to belong to *D. murchisoni*, which suggests association with the overlying Betton Member which is clearly of *D. murchisoni* age. The trilobites apparently support this interpretation (Whittard 1966: 297). The preservation of the graptolites is usually poor.

Betton Member. The shales of this unit are characterized by the abundance of large pendent didymograptids, generally assigned to *D. murchisoni*. There are a few other forms of *Didymograptus* present and a number of localities have *Gymnograptus*(?) sp. The specimens are often distorted by cleavage and it has not been possible to undertake any detailed analysis of the forms present. This doubtful record of *Gymnograptus* suggests correlation with the comparable beds in Scandinavia where *G. linnarssoni* occurs in the beds overlying the Upper Didymograptus Shale. One of the localities for this form is put just on the boundary of the Betton and Meadowtown Members on the revised map (Whittard, ed. Dean 1979: 44, fig. 30), but the biserial forms are accompanied by *D.* cf. *murchisoni* while Hede (1951) does not record *G. linnarssoni* even in his transition beds between the *D. clavulus* and *G. linnarssoni* Zones. The difficulties in comparing the records of *Gymnograptus* from different countries are discussed on p. 46.

Meadowtown Member. In a letter to me of 3/10/55, Whittard commented of the Meadowtown Member that 'both top and bottom junctions are gradational'. He sent me several samples with the request that I decide whether they should be placed in it on the graptolite evidence alone, since at that time the *D. murchisoni* Zone below and *N. gracilis* Zone above were considered easily recognizable. Unfortunately not only are the beds generally lithologically distinct, with a rich shelly fauna in places, but the graptolites are comparatively restricted in variety: they consist largely of long-ranging forms of diplograptids whose comparative taxonomy is poorly known. Meadowtown Quarry is the type locality for *Diplograptus foliaceus* (Murchison), a species name which, as Elles & Wood noted in 1908, had been used for a wide range of different forms. It is still not possible to define its range adequately, since very similar forms are found in all the coarser units in the Shelve Inlier above the Meadowtown Member, right up to the Whittery Member at the top. They do not appear, however, in the immediately overlying shaly Rorrington Member, where a much wider range of diplograptids is found. This may reflect some change in source area; I do not think there is any good evidence for ecological control of distribution such as depth of water. The Meadowtown Member has generally been correlated with the zone of *Glyptograptus teretiusculus* by default, there being no pendent didymograptids to put it with the *murchisoni* Zone below nor nemagraptids to associate it with *N. gracilis* Zone above. The reality of the *teretiusculus* Zone has been a matter of debate for many years and the Shelve area provides little evidence to help. *Dicellograptus* sp. occurs at Loc. 164 just west of Meadowtown Quarry, about the middle of the member, while *Dicranograptus irregularis* occurs further south at a lower horizon along with *Dicellograptus vagus*. These two Swedish species were originally described from the *C. putillus* Zone and this suggests that there is something recognizable between the *murchisoni* and *gracilis* Zones.

Rorrington Member. The dark shales of the Rorrington Member have long provided beautiful specimens of graptolites, often in full or partial relief but difficult to study in comparison with the more usual silvery films of thin graptolitic sequences. Over 50 localities provide some 20 species, usually in abundance on the slabs. Lapworth (1916) divided the shales into successive *Nemagraptus* Beds and *Leptograptus* Beds and noted a *Dictyonema* horizon. There is material from a number of Whittard's localities which yields dendroids, but in the Spy Wood Brook section they cover both middle and upper parts of the Rorrington Member; there is thus not just a single recognizable horizon. The division into *Nemagraptus* and *Leptograptus* Beds seems to have been based on Manson's collecting in the stream section south of Desert (Whittard, ed. Dean 1979: 42, fig. 28) and to some extent in Holywell Brook near Rorrington. I have been unable to trace all of Whittard's localities so it is not yet possible to confirm the sequence. However, amongst the Rorrington localities there are 10 yielding *Nemagraptus* but no *Leptograptus*, 8 with *Leptograptus* but no *Nemagraptus* and 9 with both genera. Many of the localities are in the Spy Wood Burn area where Whittard's map shows some complicated faulting, but there are suggestions that locally *Nemagraptus* Beds occur below *Leptograptus* Beds. The rest of the fauna includes *Dicranograptus brevicaulis*, *D. rectus*, *Dicellograptus sextans*, *D. salopiensis*, *D. divaricatus*, *D. intortus*, various climacograptids and rarer orthograptids. Many of these are also found in the overlying Spy Wood Member. There is no doubt that this represents a typical *N. gracilis* Zone assemblage and it is unfortunate that the members below and above have such a different lithology that the succession of faunas is obscured by facies-imposed differences.

Spy Wood Member. There are about a dozen localities in this basically sandy member which yield graptolites, but generally they have only two or three species each so that proper zonal consideration is not possible. Dicellograptids and dicranograptids continue from the Rorrington Member, as do various diplograptids, but there are no *Leptograptus* or *Nemagraptus*. The latter, however, is found in the beds near Rorrington Hall which were labelled 'passage beds from Rorrington to Spy Wood', so it is possible that the absence of *Nemagraptus* is simply the result of different facies. This is important since high Costonian trilobites have been recorded from the Spy Wood Member, suggesting that some at least of the basal Caradocian is to be assigned to the *N. gracilis* Zone. *Orthograptus uplandicus* is the most widespread species in this member but it also occurs in the Rorrington Member and possibly in the Aldress Member, so that it is not a great deal of use stratigraphically.

Aldress Member. There are several species which are found only in this unit, such as *Lasiograptus costatus*, *Dicranograptus ramosus spinifer* and *Corynoides*, but apart from the first of these they are all very rare and do not greatly help stratigraphically. Elles & Wood (1908) record *L. costatus* from *gracilis* to *wilsoni* Zones and there are only a few records from outside Britain, none of which agree with the British material. In the absence of *Nemagraptus*, *Dicellograptus* and *Leptograptus*, it is tempting to assume that the Aldress Member cannot be in the *gracilis* Zone, but there is as yet no detailed account available of the ranges of species in Britain in this part of the geological column. The Builth succession apparently does not go above the *gracilis* Zone and the succession in the Dicranograptus Shales of south Wales shows considerable differences particularly the occurrence of *Dicellograptus* spp. and *Dicranograptus* spp. in the *arctus* Beds and *Mesograptus* Beds which are the most likely equivalents of the Aldress Member (Strahan *et al.* 1914).

Hagley Volcanic Member. There are only a few localities of this unit in the Whittard Collection from which he sent me graptolites. The initial indication was of a horizon much lower than had been generally accepted. Re-examination of the specimens in the Survey collection identified by Miss Elles showed the presence of a single specimen of *Climacograptus peltifer*, suggesting a low Caradoc horizon which agreed with the trilobite evidence. The rest of the fauna consists of other climacograptids and probably some orthograptids. It has been common practice to refer these to a *D. multidens* Zone which is post-*gracilis* and pre-*clingani*, but the term is unfortunate as *D. multidens* seems to be virtually confined to its type area at Pontesford and only a single

specimen appears in the Whittard Collection from the Aldress Member. Many records of *D. multidens*, based on thecal count, are in fact *D. foliaceus* which has a long range in Shelve from Meadowtown to Whittery Shale Members. However, until a revision of the ranges of the various diplograptids in this part of the Ordovician is available, the subdivision of the graptolitic sequence remains uncertain.

Hagley Shale, Whittery Volcanic and Whittery Shale Members. These all have virtually the same fauna, consisting of biserial forms, *Climacograptus*, *Pseudoclimacograptus*, *Diplograptus* and *Orthograptus*. Most of the species are also found in the Aldress Member and it is difficult to know how much higher than the *gracilis* Zone the succession goes. I would prefer to keep them in the *C. peltifer* Zone but the total absence of *Dicellograptus* and *Dicranograptus* limits comparisons with areas such as south Wales and southern Scotland.

Systematic descriptions

Order **DENDROIDEA** Nicholson, 1872

Family **ANISOGRAPTIDAE** Bulman, 1950

Genus ***CLONOGRAPTUS*** Hall, 1873

TYPE SPECIES. *Graptolithus rigidus* Hall 1858.

Clonograptus sp.
Fig. 1; Pl. 1, fig. 11

DESCRIPTION. Rhabdosome apparently much branched, stipes 0·7 mm wide with simple thecae about 1 mm long; no trace of bithecae.

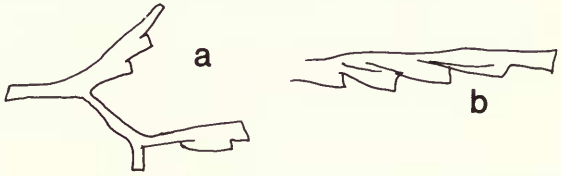

Fig. 1 *Clonograptus* sp. Q.5201, Loc. 933. a, detail of branching; b, distal thecae. Both × 10.

DISCUSSION. A single occurrence (Q.5201) is represented by crowded stipes in relief but some fragments are missing between the part and counterpart so that it is not possible to sort out the tangle of stipes. There are no indications of any sicular portions by thickening but it is possible that several rhabdosomes are present, as there are a number of places where the branching could be interpreted as initial. The length of these straight portions is only 1 mm, however, which suggests rather that they represent consecutive dichotomies in progressive branching at high angles, 90°–120°. There are no long distal stipes. Monsen (1937) gives the length of branching stipes in *C.* cf. *flexilis* (Hall) as 1–1·2 mm but this is about half the length given by Hall (1865) and Ruedemann (1947) gives 3–10 mm for the stipe length.

MATERIAL AND HORIZON. The specimen is from beds mapped as Mytton Member by Whittard (Loc. 933) and is associated with some other dendroids (Q.5202) and a few broad (2·0–2·4 mm) dichograptid stipe fragments (Q.5203).

Order **GRAPTOLOIDEA** Lapworth, 1875

Family **DICHOGRAPTIDAE** Lapworth, 1873

Subfamily **DICHOGRAPTINAE** Lapworth, 1873

Genus ***TETRAGRAPTUS*** Salter, 1863

TYPE SPECIES. *Fucoides serra* Brongniart 1828.

Tetragraptus cf. *bigsbyi* (Hall 1865)
Fig. 2

cf. 1965 *Tetragraptus bigsbyi* (Hall); Skevington: 4; text-figs 1, 3, 5, 6 (with synonymy and discussion).

DISCUSSION. A single specimen from Shelve shows the recurved stipes characteristic of this species, but only two stipes are visible. Since it is clearly not an isograptid, it is presumed to be a tetragraptid and agrees well with this species group. Details of the proximal end cannot be determined as the counterparts are broken and it is possible that this is a fragment with only two stipes; the matrix is a fairly coarse silt. The better-preserved stipe matches fairly well with the lectotype as figured by Skevington (1965), but is less curved and the thecae may not be fully developed since the width of the stipe is much less (2·4 mm instead of 3·1 mm). In this, the specimen is close to var. *divergens* Monsen 1937, as also in the number of the thecae (15–16 per cm), but the shape of the proximal end does not agree with the Norwegian form. Since the specimen is incomplete, it seems best to leave the identification fairly open.

MATERIAL AND HORIZON. The specimen (Q.5204) is associated with the proximal end of a didymograptid (Q.5205), specifically indeterminate, and is from the Mytton Member (Loc. 779).

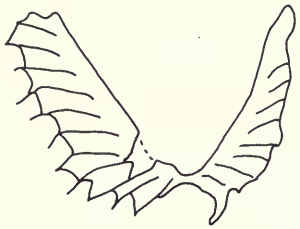

Fig. 2 *Tetragraptus* cf. *bigsbyi* (Hall). Q.5204, Loc. 779. × 5.

?*Tetragraptus* sp.
Pl. 1, fig. 13

A single specimen (Q.5206) occurs alone at Loc. 279 (Whittard, ed. Dean 1979: 19) and consists apparently of two reclined stipes arising from a rather square axil. The longer stipe is 28 mm long and reaches a width of 1·6 mm, with 10 thecae per cm. Close examination suggests that

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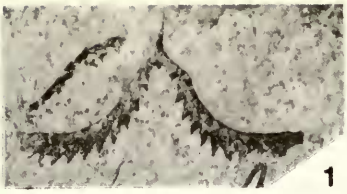
PLATE 1 All specimens from the Mytton Member.

Fig. 1 *Corymbograptus deflexus* (Elles & Wood), p. 20. Q.5246, Loc. 720[1]. × 3. See also Text-fig. 11, p. 20.
Figs 2–5 *Expansograptus* cf. *nitidus* (Hall), p. 18. Fig. 2, Q.5235, Loc. 720[2]. Fig. 3, Q.5236, Loc. 720[1]. Fig. 4, Q.5237, Loc. 720[7]. Fig. 5, BU.2074 (J. T. Wattison collection), Shelve Church. All × 3.
Fig. 6 *Corymbograptus* cf. *inflexus* (Chen & Xia, *in* Mu *et al.* 1979), p. 21. BU.2075, Shelve Church. × 3. See also Text-fig. 12, p. 21.
Fig. 7 *Expansograptus* cf. *simulans* (Elles & Wood), p. 19. Q.5242, Loc. 905. × 2.
Fig. 8 *Isograptus* sp., p. 21. Q.5247, Loc. 791. × 3. See also Text-fig. 13, p. 22.
Fig. 9 *Expansograptus* cf. *hirundo* (Salter), p. 18. Q.5234, Rhodes Locality (Tankerville Flags). × 3.
Fig. 10 *Glyptograptus shelvensis* Bulman, p. 38. BU.2076, Shelve Church. × 6.
Fig. 11 *Clonograptus* sp., p. 7. Q.5201, Loc. 933. × 3.
Fig. 12 *Glyptograptus dentatus* (Brongniart), p. 37. Q.5307, Loc. 905. × 3. See also Pl. 2.
Fig. 13 ? *Tetragraptus* sp., above. Q.5206, Loc. 279. × 3.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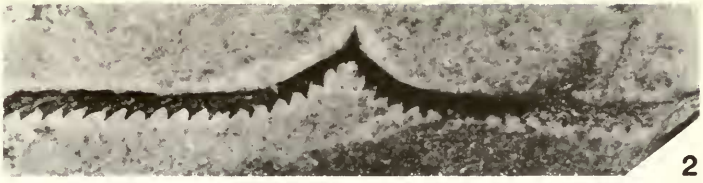
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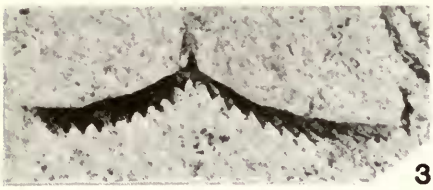
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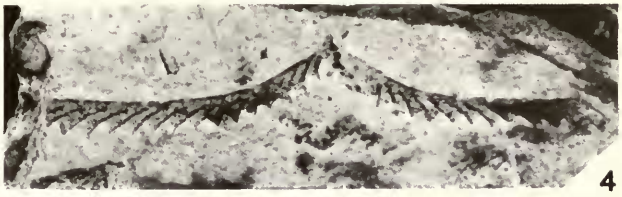
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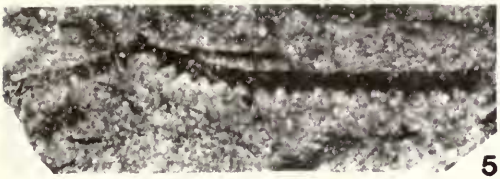
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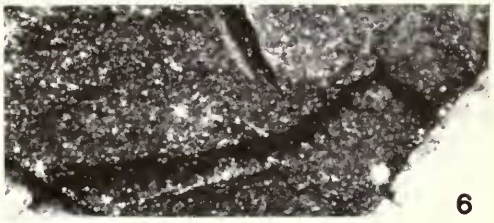
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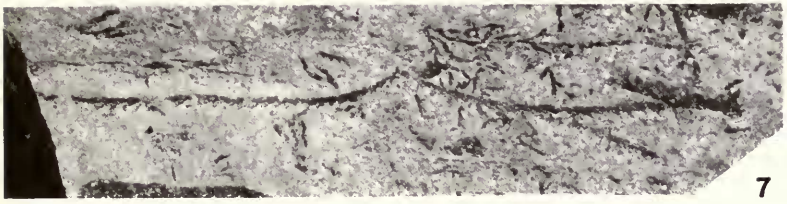
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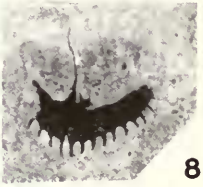
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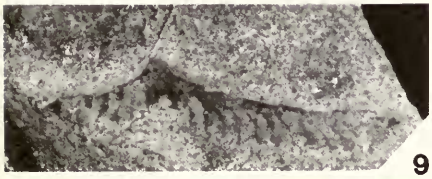
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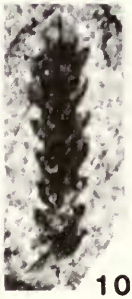
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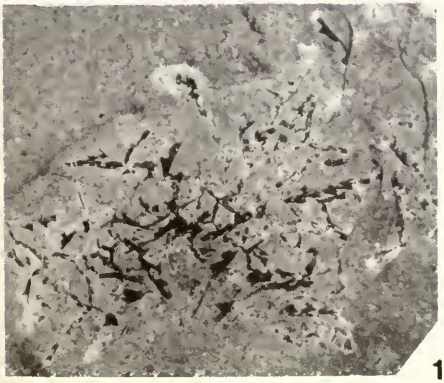
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there may be a second pair of stipes superimposed on the obvious one; the whole structure looks much more like a reclined tetragraptid than a distorted didymograptid. The stipes, however, are much narrower than most of the described species of *Tetragraptus*. The small species described from China (Geh 1964, etc.) have only short stipes which are also curved.

Genus ***PSEUDOPHYLLOGRAPTUS*** Cooper & Fortey, 1982

TYPE SPECIES. *Phyllograptus angustifolius* Hall 1858.

Pseudophyllograptus cf. ***angustifolius*** (Hall 1858)
Fig. 3; Pl. 2, fig. 1

cf. 1858 *Phyllograptus angustifolius* Hall: 139.
cf. 1982 *Pseudophyllograptus angustifolius angustifolius* (Hall) Cooper & Fortey: 242; text-figs 48e, f (with synonymy).

Fig. 3 *Pseudophyllograptus* cf. *angustifolius* (Hall). Q.5207b, Loc. 635. Counterpart of Pl. 2, fig. 1, $\times 2\frac{1}{2}$.

A single specimen (Q.5207) has been found among the Shelve material which matches most of the descriptions of this widespread species. It is 18 mm long and has a maximum width of 4 mm, which is attained in the first 10 mm of growth, and the rhabdosome tapers distally. The thecae are simple tubes, highly inclined to the length of the rhabdosome and number 7 in the first 5 mm, reducing to 6 in 5 mm distally. They bear short ventral projections. The specimen is not well preserved but appears to show the lateral view of two stipes with only traces of the central series being indicated proximally. It is from the Hope Member, Loc. 635.

Pseudophyllograptus(?) cf. ***glossograptoides*** (Ekström 1937)
Fig. 4; Pl. 2, fig. 2

cf. 1937 *Phyllograptus glossograptoides* Ekström: 35; pl. 6, figs 26–33.

Another single specimen (Q.5208) from the Hope Member (Loc. 922) also shows the characteristic phyllograptoid thecal arrangement proximally, but it is shorter and wider than the previously described specimen. It is only 10 mm long but reaches a width of 4·8 mm in the first few mm which is then maintained throughout. The thecae number 12 per cm and bear well-developed ventral processes which Ekström (1937) regarded as characteristic of his species. In the absence of a good proximal end, it is not possible to decide whether Ekström's species should be put into *Pseudophyllograptus* or retained in the rarer genus *Phyllograptus*. It has no associates.

Fig. 4 *Pseudophyllograptus* (?) cf. *glossograptoides* (Ekström). Q.5208, Loc. 922. Drawing of Pl. 2, fig. 2, $\times 2\frac{1}{2}$.

Genus *DIDYMOGRAPTUS* M'Coy, 1851

TYPE SPECIES. *Graptolithus Murchisoni* Beck 1839.

The genus *Didymograptus* is here restricted to pendent forms and the classification of other two-stiped forms is discussed on p. 15 under *Expansograptus*. Skevington (1973) has briefly discussed the difficulties in assigning pendent didymograptids to species and Cooper & Fortey (1982) have also considered the problem. Bouček (1973) concluded that the type of proximal end development was a clear specific character in forms which were otherwise homoeomorphic and Cooper & Fortey have raised this character to subgeneric rank. Unfortunately it is not possible to tell in many cases whether th1[1] or th1[2] is the dicalycal theca even in the partially three-dimensional material from Shelve, and the critical identification of specimens on this character is not possible. There are very few localities in the Shelve area which provide young specimens and there is extensive proximal thickening in most adults which obscures details of the proximal end. Even the attempt to distinguish obverse from reverse views is often impossible, although it generally appears that th1[1] leaves the sicula above the sicular aperture while th1[2] extends downwards from the actual aperture. The proximal end is obviously asymmetrical at first. It is possible that the distal apertures of the two stipes do not point in the same plane, at least in the proximal part, and this can lead to apparent differences of width in the two stipes. The level of origin of th1[1] on the sicula is sometimes clear and appears to be generally low in the Shelve Llanvirn material, in contrast with the high position recorded by Cooper & Fortey for the true *D. bifidus*. However, the broadening of the sicular area which is produced in this way does not seem to be a useful character in flattened material, since similar broadening certainly occurs as secondary thickening in specimens where the origin of th1[1] can be seen to be low.

If the divisions of the old *Didymograptus*, such as *Expansograptus*, are kept as subgenera along with the precisely-defined *Didymograptellus*, it is difficult to provide a suitable nomenclature for all those pendent forms (the majority of the species) whose proximal development is not known, unless *D.* (*Didymograptus*) is regarded as a 'sack' genus. Since there are no pendent didymograptids in the Arenig of Shelve, and therefore presumably no *Didymograptellus*, the pendent forms are all put into *Didymograptus* s.str. for the present. The main nomenclatural problem is then deciding on names for the forms which have hitherto been called *D. bifidus* (Hall). When I first examined the material from the Hope Member many years ago, I identified some of the specimens as *bifidus* and others as *murchisoni*, although according to standard lists the two were not supposed to occur together. With the recent proliferation of names (as noted by Cooper & Fortey 1982: 218) there is no difficulty in finding one to match each specimen, but when populations are considered it is clear that the names do not signify species. Unfortunately the preservation of most of the Shelve specimens is not good enough for consistent measurements to be made and most individual localities have too few specimens for any reliable analysis. The rate of stipe increase, however, using the ratio of width at 10 mm to width at 5 mm, shows a fairly consistent trend in the larger specimens from the Llanvirn which goes some way towards satisfying the subdivision into two zones (Fig. 5).

More recently, Jenkins (1983) has proposed the name *D. pluto* for a wide variety of forms from the Great Paxton borehole, on the assumption that a single variable population is present. He thus includes under one name specimens which Skevington (1973) had referred to *D. acutus* Ekström, *D. artus* Elles & Wood, *D. murchisoni* (Beck), *D. speciosus* Ekström and *D.* cf. *geminus* (Hisinger), and incidentally changes the horizon from Upper to Lower Llanvirn. Jenkins, however, believes that all the pendent didymograptids of the rest of Britain have th1[1] dicalycal while *D. pluto* has th1[2] dicalycal, and therefore concludes that the Great Paxton graptolites have no connection with those of Wales and the Welsh Borders. Since the material from Shelve of both *D.* '*bifidus*' and *D. murchisoni* can be shown to have th1[2] dicalycal in some specimens, there is no need to regard the Great Paxton material as being in a totally different province, as indeed the similarities in the trilobites (which Jenkins ignores) demonstrate, and the relationship of *D. pluto* to the range of forms at Shelve needs to be considered. An exactly

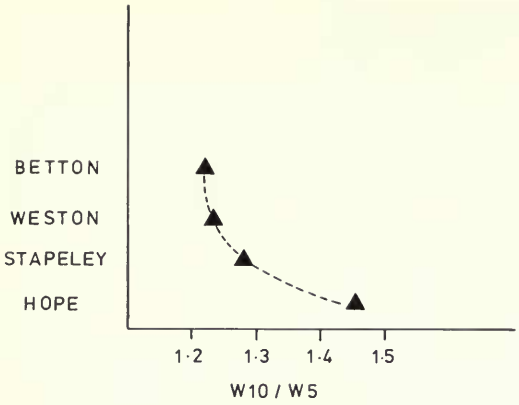


Fig. 5 Mean values of the ratio of stipe width at 10 mm and 5 mm from the sicula for pendent didymograptids of *murchisoni*-type in relation to horizon.

similar range of forms can be found in the Hope Member but neither preservation nor abundance is good enough to allow real statistical comparison. From the little which can be done, it is clear that the average figures agree fairly well with Jenkins' study. If this approach to populations is approved, then the naming of specimens from different localities becomes very difficult as Cooper (1973) demonstrated for *Isograptus*. Individual morphotypes have a long range. If stratigraphical usefulness is required, the population approach gives good results but single specimens cannot be given a precise name. Jenkins provides only two differences between *D. pluto* and *D. murchisoni*, but since some at least of *D. murchisoni* have th1^2 dicalycal, his only remaining difference is that *murchisoni* has a slightly wider thecal spacing on average (14·3 per cm) than *pluto* (17·2 per cm distally): see, however, p. 14. Although the numbers in the Shelve collections are small, a very similar difference in thecal spacing is seen between the specimens from the Hope Member and from the Betton Member, in both the Whittard and the Lapworth collections. One of the main differences given by Nicholson (1870) between '*bifidus*' and *murchisoni* is the greater thecal count in *bifidus*, although the figures he gives are lower than those given by Jenkins.

If this broad concept of a species is accepted, then it is apparent that there are very few species of pendent didymograptids in the Shelve Inlier. The early ones can be called *D. pluto* and the common one in the uppermost Llanvirn clearly matches *D. murchisoni*. There remain a few specimens which cannot easily be fitted into these two. These have comparatively slender stipes which are almost uniform in width and were put by Elles & Wood into their *indentus* Group. Jenkins has illustrated a few specimens of his *D. pluto* which show little if any increase in width of stipes with length and these have clearly a different growth pattern from the rest of his specimens. They are similar to *D. indentus* (Hall) but this Levis species is poorly known and has been largely ignored by American workers. The Russian and Chinese specimens have probably been assigned to it mainly on the thecal count. *D. stabilis* and *D. miserabilis* have the same growth pattern. In contrast *D. artus*, which Elles & Wood put in this group, does not, having the more usual continued increase. There are too few specimens in the Shelve collections to allow any analysis of character range in these forms and so they will be treated as separate species for the present.

Didymograptus murchisoni (Beck 1839)
Pl. 3, figs 8, 9, 11–14

1839 *Graptolithus Murchisonii* Beck *in* Murchison: 694; pl. 26, figs 4, 4a.
1901 *Didymograptus Murchisoni* (Beck); Elles & Wood: 37; pl. 3, figs 1a–k; text-figs 24a–c.
1901 *Didymograptus Murchisoni* var. *geminus* (Hisinger); Elles & Wood: 40; pl. 3, figs 2a–c, ?d–j; text-figs 25a–c, ?d.
1984 *Didymograptus murchisoni* (Beck); Strachan & Khashogji: 223; figs 1–7.

DESCRIPTION. Rhabdosome variable but generally stout, often 2·5 to 3·0 cm long, widening from 0·75 mm at th1[1] to 1·4 mm in the first 10 mm and thereafter to 2·0 mm or even 2·5 mm. The stipes diverge initially at about 90° but rapidly curve to become nearly parallel, although some specimens remain divergent. The sicula has a length of 1·5–2·0 mm and the initial bud appears fairly low down. The proximal end is usually secondarily thickened in mature specimens and details of development obscure, but some specimens show clear indication of isograptid development, th1[2] being the dicalycal theca. Thecae number 16 per cm proximally and 14–15 per cm distally. The thecae are simple tubes, curved distally so that they are inclined at about 35° to the dorsal wall of the stipe proximally but at 50°–70° distally. Thecal overlap varies from about half at the proximal end to three-quarters distally. A few large specimens show complete overlap at the distal end where the thecae are very curved and open at right angles to the stipe length.

DISCUSSION. An account of the type material of *D. murchisoni* from the Builth–Llandrindod inlier has been prepared separately (Strachan & Khashogji 1984). If the population approach to species (p. 12) is accepted, then the various forms previously listed from the higher beds of the Llanvirn (Strachan 1981) as *D. pandus*, *D. speciosus*, *D. geminus* and *D. acutus* should all be regarded as within the one species for which *D. murchisoni* is the appropriate name. The distinction between this species and *D. pluto* is probably purely statistical but has stratigraphical usefulness, although it may be difficult to determine where to put the arbitrary boundary. Stratigraphically, the faunas of the Weston Member appear to belong with the Betton Member, particularly in the rate of increase of stipe width as measured by the ratio of width at 10 mm to width at 5 mm which is less than 1·25. In the Hope Member this ratio is 1·4.

MATERIAL AND HORIZONS. The species is the commonest in the Weston and Betton Members where, however, it has few associates. Weston: Q.5212, Lyde Stream; Q.5213, Loc. 444. Betton: Q.5209, Loc. 382A; Q.5210, Loc. 307; Q.5211, Loc. 437; Q.5227, Loc. 536; Q.5344, Loc. 232. The last two localities appear to be at the upper limit of the Betton Member and also contain *Gymnograptus*(?) sp.

Didymograptus pluto Jenkins 1983
Fig. 6; Pl. 2, figs 5–7, 11, 13

1983 *Didymograptus pluto* Jenkins: 642, text-figs 2A, B, 3A, C–G, I–K, M–R, T, U, 4A–C (? *non* figs 3B, H, L, S)

DESCRIPTION. Rhabdosome variable in size and shape but generally with straight stipes 2·0–2·5 cm long, diverging ultimately at 15°–35°. The stipes widen fairly rapidly from an initial 0·5–0·6 mm to 1·0 mm at 5 mm from the sicula and 1·6 mm at 10 mm. The maximum width is rarely more than 2·0 mm although one specimen with a stipe length of 3·7 cm has a width of

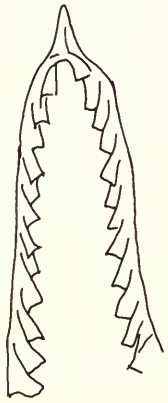


Fig. 6 *Didymograptus pluto* Jenkins. Q.5214, Loc. 169. × 5.

2·4 mm. The thecae number 8–9 in the first 5 mm and about 16 per cm distally. The sicula is 1·2–1·6 mm long and the proximal end of the rhabdosome is frequently thickened so that the details of development cannot be seen. Some specimens, however, show that $th1^2$ is dicalycal and the development is early isograptid.

DISCUSSION. Jenkins (1983) has described the species on the basis of population studies and although it is very varied morphologically there appears to be good evidence for it being a single species. It probably represents most of what British authors have previously called *D. bifidus*, from which it is distinguished by the much longer sicula and low position of the initial bud. It appears to be only statistically different from *D. murchisoni*, the main difference being in the thecal count, but there is also a difference in the rate of widening of the stipes, *D. pluto* widening initially much more rapidly than *D. murchisoni*. *D. pluto* includes forms which have previously been referred to *D. murchisoni* and its allies (*geminus*, *speciosus*, etc.), and my preliminary lists from Shelve included these forms from the Hope Member. I am happy to include them now under a single name as stratigraphically and biologically this makes sense. Cooper & Fortey (1982: 224) have suggested that *D. spinulosus* Perner 1895 may be the senior name available for British *D.* '*bifidus*'. This species however is a member of the *indentus* Group of Elles & Wood (see p. 12), having a basically uniform width of the more or less parallel stipes.

MATERIAL AND HORIZONS. Hope Member: Q.5214, Q.5220, Loc. 169; Q.5215, Loc. 54; Q.5216, Loc. 222A; Q.5218, Loc. 834; Q.5219, Loc. 204; Q.5221, Loc. 959; Q.5224, Loc. 635. Stapeley Member: Q.5217, Q.5222, Q.5223, all Loc. 133.

D. pluto is the common form certainly in the Hope Member and probably also in the succeeding Stapeley Member, but there are too few specimens in the latter for an adequate comparison. In the Hope Member it is associated with extensiform didymograptids as well as rare phyllograptids. In the Stapeley Member, the pendent didymograptids are found with rare *Glossograptus* and *Acrograptus*.

Didymograptus aff. ***miserabilis*** Bulman 1931
Fig. 7

aff. 1931 *Didymograptus miserabilis* Bulman: 40; pl. 2, fig. 12.

DESCRIPTION. Stipes up to 1 cm long and 0·8 mm wide, parallel for most of their length. Thecae number 15 to 16 per cm. The sicula is slender and about 1 mm long.

DISCUSSION. Only two specimens have been found of this small, slender species and neither is well preserved. However, it is clear that they are not just young specimens of the larger forms, nor can they be fitted into the range of any reasonable population spectrum of such forms. The sicula is shorter than reported by Bulman but it is clearly broken in one specimen.

MATERIAL AND HORIZONS. One specimen, Q.5225, occurs in the Stapeley Member, Loc. 463, and one in the Betton Member, Q.5226, Loc. 536, where it is associated with *D. murchisoni*, a similar horizon to the Peruvian occurrence.

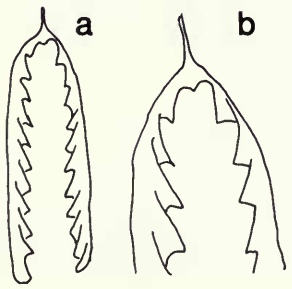


Fig. 7 *Didymograptus* aff. *miserabilis* Bulman. Q.5225, Loc. 463. a, × 5; b, proximal end × 10.

Didymograptus cf. ***stabilis*** Elles & Wood 1901
Fig. 8; Pl. 2, fig. 8

cf. 1901 *Didymograptus stabilis* Elles & Wood: 49; pl. 4, fig. 2; text-figs 31a, b.

DESCRIPTION. Stipes up to 3 cm long but usually much shorter, diverging initially at about 90° but rapidly becoming subparallel; widening from 0·5 mm to 1·3 mm in the first 10 mm and then uniform, although long specimens may reach 1·6 mm width. Thecae number 18 to 20 per cm; sicula 1·5–1·8 mm long, slender with initial bud appearing fairly low, th1[2] dicalycal, proximal end thickened in old specimens.

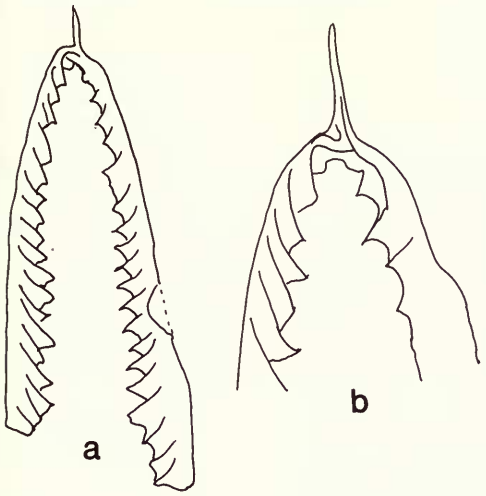


Fig. 8 *Didymograptus* cf. *stabilis* Elles & Wood. Q.5228, Hope Member, exact locality unknown. a, × 5; b, proximal end × 10.

DISCUSSION. Although the thecal count of the Shelve specimens is much higher than that given by Elles & Wood, they fit this species in general form, i.e. parallel stipes, medium size and long sicula. As I believe that *D. artus* has the different growth form of continual increase in width with length (whatever may be the realities of its proximal development), the high thecal count must be taken as parallelism.

MATERIAL AND HORIZONS. Hope Member: Q.5229, Loc. 635; Q.5230, Loc. 140. Stapeley Member: Q.5232, Loc. 133. Betton Member: Q.5231, Loc. 307. The form is fairly common in the Hope and Stapeley Members but appears to be rare in the Betton Member.

Genus ***EXPANSOGRAPTUS*** Bouček & Přibyl, 1951

TYPE SPECIES. *Graptolithus extensus* Hall 1858.

Cooper & Fortey (1982) have discussed the problems of taxonomy of extensiform didymograptids but retain both *Expansograptus* and *Corymbograptus* as subgenera of *Didymograptus*. As noted above, this leaves the nomenclature of pendent forms whose development is unknown in a very unsatisfactory state, as *Didymograptus* s.str. becomes a 'sack' genus, a contradiction in terms. I prefer to keep *Expansograptus* and *Corymbograptus*, unsatisfactory groupings as they are, at generic level from the practical point of view along with *Acrograptus* (which Cooper & Fortey accept only because they put it in a separate subfamily). There seems little point at the moment in stressing the development of the proximal end in the nomenclature when so little is known and some at least of the statements which have been made about development in particular cases are wrong. These generic names have been around for quite a long time now and need refining (like many others), but this cannot be done until we have a better understanding of the nature of the actual species involved. There are virtually no population studies available but a multitude of names, many of which are probably synonyms, and

no modern stratigraphical studies of the classic type areas. Until the range of species in populations and the stratigraphical range of such forms is adequately documented, discussion on phylogenetic units is meaningless. For example, if *D.* (*E.*) *extensus* (Hall) (Cooper & Fortey 1982: 231) is restricted to forms in which the branches diverge immediately from the sicula and consequently British '*extensus*' can no longer be incorporated in it, can *D. nitidus* (Hall) show enough variation in proximal end shape to accommodate the British '*extensus*'? Probably it can (and I have done so here) but Elles & Wood noted that *nitidus* in Britain seemed more variable than the Canadian types. If *extensus* was absent from the boreal realm (Cooper & Fortey 1982: 234), which implies a particular Arenig palaeogeography, are the boreal forms more variable than the tropical ones and what are the implications of this for comparative taxonomy?

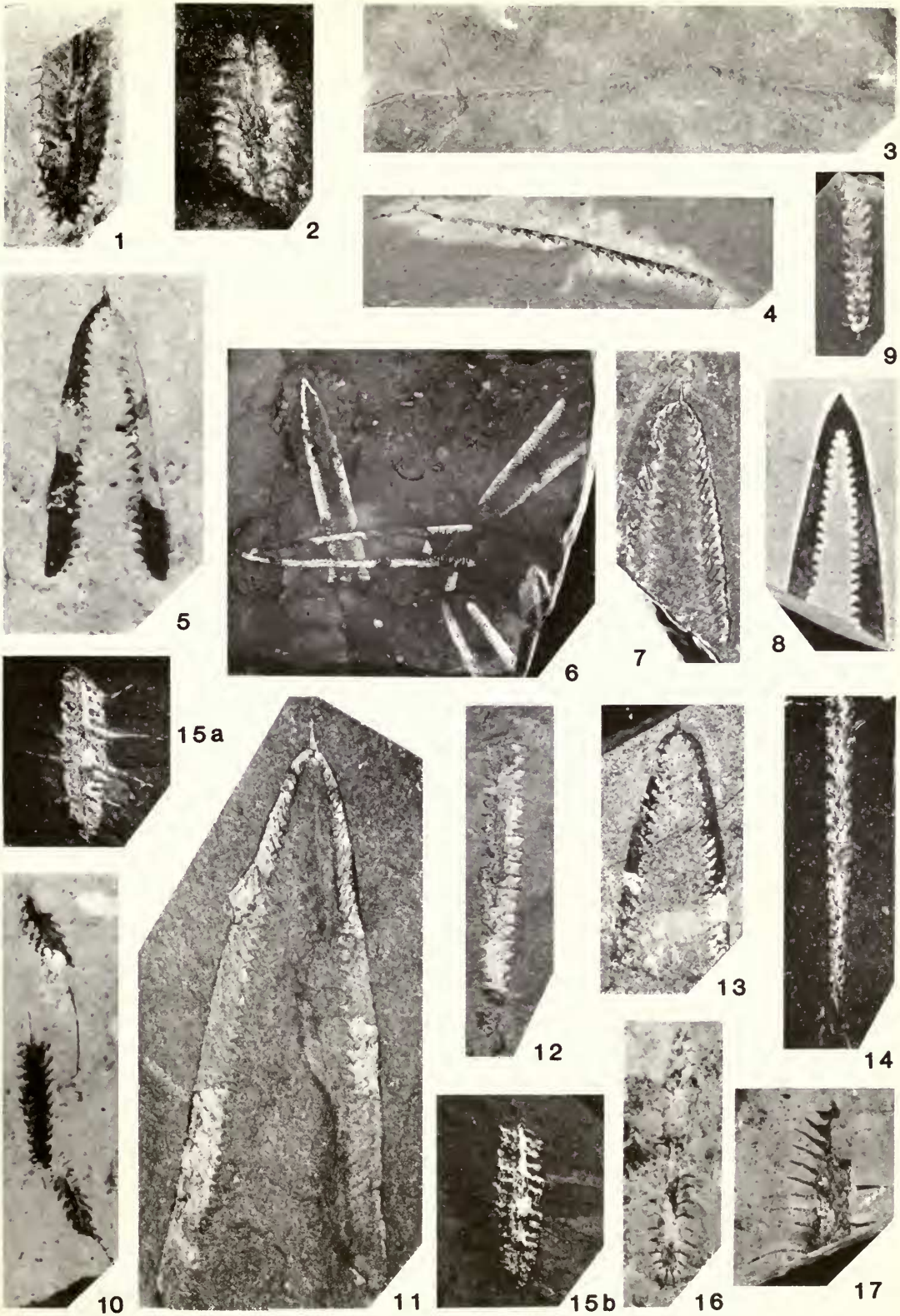
Expansograptus cf. ***euodus*** (Lapworth 1875)

cf. 1875 *Didymograptus euodus* Lapworth: 645; pl. 35, figs 1a–c.
cf. 1901 *Didymograptus euodus* Lapworth; Elles & Wood: 21; pl. 1, figs 10a, b; text-fig. 12.

A single long dichograptid stipe without proximal end appears to belong to this species. It is 15 cm long and has a uniform width of about 2 mm. The thecae are simple, slightly curved tubes, overlapping about half of their length and there are 8 per cm. The angle of inclination appears to be higher than given by Lapworth (30°–40°) but the curvature of the thecae makes exact measurements difficult. In the absence of a proximal end, only general comparison can be made and of the species recorded from Britain at about this horizon *E. euodus* appears to be the best fit. The specimen (Q.5233) is associated with numerous pendent didymograptids characteristic of the Hope Member, at Loc. 169.

PLATE 2 Figs 1–12, 14, 15 from the Hope Member; Figs 13, 16, 17 from the Stapeley Member.

Fig. 1 *Pseudophyllograptus* cf. *angustifolius* (Hall), p. 10. Q.5207a, Loc. 635. × 3. See also Text-fig. 3, p. 10.
Fig. 2 *Pseudophyllograptus*(?) cf. *glossograptoides* (Ekström), p. 10. Q.5208a, Loc. 922. × 3. See also Text-fig. 4, p. 10.
Figs 3, 4 *Acrograptus acutidens* (Elles & Wood), p. 22. Fig. 3, BU.2077 (Lapworth Collection), Ritton Castle, Shelve. × 2. Fig. 4, Q.5249, Loc. 701. × 3. See also Text-fig. 15, p. 22.
Figs 5–7 *Didymograptus pluto* Jenkins, p. 13. Fig. 5, Q.5215, Loc. 54. × 3. Fig. 6, Q.5216, Loc. 222A. × 1. Fig. 7, BU.2078 (Lapworth Collection), Snailbeach Stream (Hogstow Brook). × 3.
Fig. 8 *Didymograptus* cf. *stabilis* Elles & Wood, p. 15. Q.5229, Loc. 635. × 3.
Fig. 9 *Amplexograptus* cf. *confertus* (Lapworth), p. 36. Q.5303, Loc. 959. × 3.
Fig. 10 *Glyptograptus dentatus* (Brongniart), p. 37. Q.5308, Loc. 701. × 3. See also Pl. 1.
Fig. 11 *Didymograptus pluto* Jenkins, p. 13. BU.2079 (Lapworth Collection), Snailbeach Stream (Hogstow Brook). × 3.
Fig. 12 *Glyptograptus* sp., p. 39. Q.5310, Loc. 959. × 3. See also Text-fig. 33, p. 39.
Fig. 13 *Didymograptus pluto* Jenkins, p. 13. Q.5217, Loc. 133. × 3.
Fig. 14 *Climacograptus* cf. *angustatus* Ekström, p. 41. Q.5324 (Illing collection), Hope Member, exact locality unknown. × 3.
Fig. 15a, b *Glossograptus* cf. *armatus* (Nicholson), p. 24. Q.5256 (Illing Collection), Hope Member, exact locality unknown. Two views to show different detail. × 3. See also Text-fig. 20, p. 24.
Fig. 16 *Glossograptus fimbriatus* (Hopkinson), p. 24. Q.5255, Loc. 133. × 3. See also Text-fig. 19, p. 24.
Fig. 17 *Glossograptus* cf. *acanthus* Elles & Wood, p. 23. Q.5254, Loc. 132. × 3. See also Text-fig. 18, p. 24.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Expansograptus cf. *hirundo* (Salter 1863)
Pl. 1, fig. 9

cf. 1863 *Didymograpsus hirundo* Salter: 137, fig. 13f.
cf. 1901 *Didymograptus hirundo* Salter; Elles & Wood: 15; pl. 1, figs 5a–c; text-figs 9a–c.

DESCRIPTION. Stipes up to 6 cm long, widening from 1·6 mm at th1[1] to 2·2 mm at th5 and probably continually afterwards but more slowly, the longest stipes having widths of 2·5–2·8 mm. Thecae 12 to 10 per cm, strongly curved at the proximal end and inclined at 60°–80°, overlapping three-quarters or more.

DISCUSSION AND OCCURRENCE. A single specimen (Q.5234) shows the compact proximal end characteristic of *E. hirundo* and a number of long stipe fragments have thecae with a fairly high inclination which match those figured by Elles & Wood. They occur in the uppermost part of the Mytton Member (Rhodes locality, Tankerville Flags).

Expansograptus cf. *nitidus* (Hall 1858)
Pl. 1, figs 2–5

cf. 1858 *Graptolithus nitidus* Hall: 129.
cf. 1901 *Didymograptus nitidus* (Hall); Elles & Wood: 10; pl. 1, figs 2a–c; text-figs 5a–d.
cf. 1982 *Didymograptus* (*Expansograptus*) *nitidus* (Hall); Cooper & Fortey: fig. 40f, g.

DESCRIPTION. Stipes up to 2 cm long, diverging at varying angles from the sicula but rapidly becoming horizontal, widening fairly rapidly from 0·8–1·0 mm at th1 to a maximum of 1·6 mm. Thecae 12 to 10 per cm. Sicula 1·4–1·6 mm long, th1[1] arising near the apex, development of isograptid type.

DISCUSSION. Following the redescription of *E. extensus* by Cooper & Fortey (1982), stressing the initial horizontal growth of the stipes in that species, forms which had previously been identified as *D. extensus* have been grouped with those of *E. nitidus* from Shelve. The distinction made earlier (Strachan 1981) was based on the amount of proximal curvature, the more curved forms being put in *nitidus* (as *Corymbograptus*), the less curved forms as *extensus* relying on Elles & Wood's description. Most of the specimens are deformed to some extent so that detailed comparative measurements are impossible but the specimens all appear to be wider proximally than in Canadian material. However, the sicular details are similar and also agree with those of *E. extensus*, so they are placed in *Expansograptus*.

MATERIAL AND HORIZON. The species occurs in the Mytton Member and is fairly common at Shelve Church (Loc. 720: Q.5235–7). It is also found at Bergam Quarry (Loc. 783: Q.5238).

Expansograptus cf. *praenuntius* (Törnquist 1901)
Fig. 9

cf. 1901 *Didymograptus praenuntius* Törnquist: 17; pl. 2, figs 7–12.
cf. 1982 *Didymograptus* (*Expansograptus*) *praenuntius* Törnquist; Cooper & Fortey: 235; fig. 43a, b; pl. 4, fig. 12.

DESCRIPTION. Stipes 10 mm long, widening rapidly from 1·2 mm at th1 to 1·7 mm at th4, then uniform, extending horizontally from the sicula. Thecae 10 per cm. Sicula 2·2 mm long.

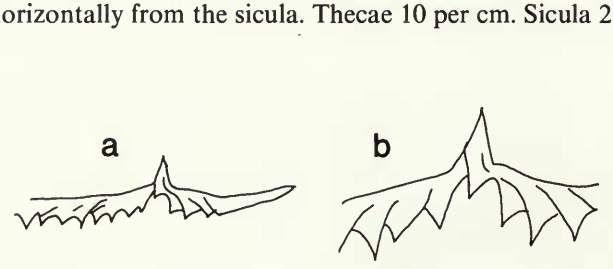


Fig. 9 *Expansograptus* cf. *praenuntius* (Törnquist). Q.5239, Loc. 783, Bergam Quarry. a, ×2½; b, proximal end, × 5.

Discussion and occurrence. A single specimen (Q.5239) in the collection was identified as this species by O. M. B. Bulman and agrees fairly well with the most recent account by Cooper & Fortey. The specimen is from Bergam Quarry (Loc. 783) in the highest part of the Mytton Member and this occurrence strongly supports the view that the Mytton Member is largely pre-*hirundo* Zone. There are, however, broad stipes associated with it which Bulman identified as *D. hirundo* and a single proximal end, possibly from the same locality, has something of the compact structure seen in *hirundo*. Since there are only some 20 specimens from the quarry, most of which are single stipe fragments, the real nature of the population is uncertain.

Expansograptus cf. ***simulans*** (Elles & Wood 1901)
Pl. 1, fig. 7

cf. 1901 *Didymograptus simulans* Elles & Wood: 30; pl. 2, figs 6a, b; text-figs 19a–c.

Description. Stipes 2·5 cm long, diverging from the sicula at 135° but soon becoming horizontal, width 0·4 mm initially, widening slowly to 0·8 mm. Thecae 14 to 12 per cm, inclined at 25°–30°, overlapping less than half in the proximal thecae but half to two-thirds distally. Sicula short, 0·8 mm long.

Discussion and occurrence. Two poorly preserved specimens (Q.5242, Loc. 905 and Q.5243, Loc. 853A) from the Mytton Member are clearly allied to this species. In appearance it is somewhat like a rather slender *E. nitidus*, having a similar proximal curvature. It does not seem to have been recognized elsewhere. The specimen figured by Mu *et al.* (1979) as *D.* cf. *simulans* is more robust at the proximal end, as was noted by the Chinese authors.

Expansograptus cf. ***sparsus*** (Hopkinson 1875)

cf. 1875 *Didymograptus sparsus* Hopkinson: 643; pl. 33, figs 2a–d.
cf. 1901 *Didymograptus sparsus* Hopkinson; Elles & Wood: 17; pl. 1, figs 6a, b; text-fig. 10.

Another long dichograptid stipe occurs as a single specimen, Q.5244, from the Mytton Member at Shelve Church, Loc. 720. It is also about 15 cm long and has a uniform width of about 2 mm. It is poorly preserved and is noteworthy only for its length. The thecae number about 7 per cm and are simple tubes, overlapping about half of their length and inclined at about 45°. The stipe is too narrow for one of the large tetragraptids which might be expected to occur at this horizon and although there is some distortion of the specimen, the thecae are markedly fewer than in some other stipes of similar width but much shorter length which could be attributed to forms like *hirundo*.

Expansograptus cf. ***suecicus*** (Tullberg 1880)
Fig. 10

cf. 1880 *Didymograptus suecicus* Tullberg: 43; pl. 2, figs 15, 16.
cf. 1974 *Expansograptus suecicus* (Tullberg); Tzaj: 79; pl. 7, figs 6, 7; text-fig. 20.

Description. Stipe 10 mm long, widening from 1·0 mm to 1·8 mm, diverging at 120° from the sicula but quickly becoming horizontal. Thecae simple tubes, 13 to 12 per cm, inclined at about 50°, overlapping a half to two-thirds. Sicula about 1·6 mm long.

Discussion and occurrence. A single specimen from Bergam Quarry (Q.5245, Loc. 783) in the uppermost Mytton Member has some of the characters of this species but has a higher thecal count. It is wider than the associated *E.* cf. *praenuntius* but a large collection might well show intermediate forms. There is nothing precisely to match it amongst Monsen's (1937) many species. *D. enshiensis* Ni (*in* Mu *et al.* 1979) is similar but probably more curved. The precise attitude of the stipes in this specimen is uncertain since one is broken off at the sicula.

Fig. 10 *Expansograptus* cf. *suecicus* (Tullberg). Q.5245, Loc. 783. × 5.

Genus *CORYMBOGRAPTUS* Obut & Sobolevskaya, 1964

TYPE SPECIES. *Didymograpsus V-fractus* Salter 1863.

Although not specifically mentioned in the original description, this genus appears to be based essentially on Elles & Wood's deflexed series, in which the proximal end forms part of a V-shape with the stipes at first dorsally convex and later concavely curved. Tzaj (1974) lists twelve species in the genus but most of these approach the extensiform type rather than the *v-fractus* type. Cooper & Fortey (1982: 239) express reservations on their use of *Corymbograptus* as a subgenus but their *D. v-fractus* from Spitsbergen is nothing like Salter's species and their *D.* cf. *deflexus*, although clearly a *Corymbograptus*, is not very close to Elles & Wood's form. This, and their correlation of the Chinese horizons which differs from that of Mu *et al.* (1979), may have unduly influenced them. A characteristic feature of *Corymbograptus* is that the initial growth of the stipes is dorsally convex, like those of pendent didymograptids, and not concave like *E. nitidus*. All the forms with this curvature figured by Mu *et al.* (1979) are from their N3 horizon, which they equate with the lowest part of the Arenig sequence in Britain and therefore contemporary with the British forms.

Corymbograptus deflexus (Elles & Wood 1901)

Fig. 11; Pl. 1, fig. 1

1901 *Didymograptus deflexus* Elles & Wood: 35; pl. 2, figs 12a–c; text-figs 23a, b.
1933 *Didymograptus deflexus* Elles & Wood; Elles: text-fig. 13.
non 1934 *Didymograptus deflexus* Elles & Wood; Hsü: 36; pl. 2, figs 7a–c.
non 1937 *Didymograptus* cf. *deflexus* Elles & Wood; Monsen: 146; pl. 3, figs 38, 41; pl. 10, fig. 12.
non 1974 *Corymbograptus deflexus* (Elles & Wood); Tzaj; 82; pl. 8, figs 1–4.

DESCRIPTION. The sicula is 2 mm long and has a short nema. The first theca arises halfway down the sicula and gives rise to the crossing canal of the second theca almost immediately. The rest of the development cannot be seen in this specimen since it is partially broken away. $Th1^1$ diverges from the sicula above the sicular aperture but $th1^2$ grows down past the aperture. The dorsal wall of the stipe is at first convex and the stipes diverge at about 70° in the V-shape. After five or six thecae, the stipes curve again to become horizontal. The stipes reach a width of 1·5 mm and the thecae number 12 per cm.

DISCUSSION. Elles (1898) first described this form as a young stage of *C. v-fractus* but in the Monograph (Elles & Wood 1901) distinguished it as a separate species. It has the curvature of the stipes characteristic of the genus but is in all respects a smaller form than the type species. It is rare at Shelve, being represented by only one specimen in the Whittard collection, which, however, matches the holotype very closely in size and curvature of the stipes.

The species has been recorded from China, Kazakhstan and Australia but the specimens figured from the two former areas do not show the fairly sharp demarcation between the proximal V-shape and the distal extension of the stipes. Although Thomas (1960) lists the species, it does not seem to have been described from Australia and Cooper (1979) notes that one of Monsen's '*D.* cf. *deflexus*' from Norway is close to the Australasian *D. v-deflexus* Harris.

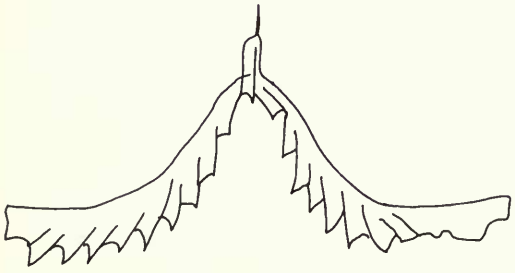


Fig. 11 *Corymbograptus deflexus* (Elles & Wood). Q.5246, Loc. 720[1]. Drawing of Pl. 1, fig. 1, × 5.

The Spitsbergen specimens figured by Cooper & Fortey (1982) have a much longer proximal section before the stipes turn outward.

MATERIAL AND HORIZON. The specimen, Q.5246, is from the Mytton Member at Shelve Church, Loc. 720.

Corymbograptus cf. ***inflexus*** (Chen & Xia 1979)
Fig. 12; Pl. 1, fig. 6

cf. 1979 *Didymograptus inflexus* Chen & Xia, *in* Mu *et al.*: 84; pl. 29, figs 8–11.

DESCRIPTION. Stipes up to 15 mm long, widening from 0·8 mm at the proximal end to 1·2 mm at 5 mm from the sicula, and remaining at that width. Thecae 7 to 6 in 5 mm, generally curved. Sicula 1·4 mm long, curved. The stipes diverge at about 125° from the sicula and are curved with convex dorsal margin for about 5 mm to make an angle of about 100° before flexing again to become sub-horizontal.

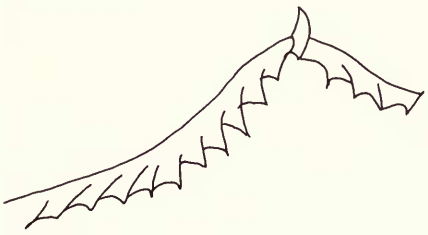


Fig. 12 *Corymbograptus* cf. *inflexus* (Chen & Xia). BU.2075, Shelve Church. Drawing of Pl. 1, fig. 6, × 5.

DISCUSSION AND OCCURRENCE. This single specimen (BU.2075) from the Shelve Church Beds (Loc. 720) is in general form close to one of the illustrations in Mu *et al.* (1979) of *D. inflexus* and the measurements match that species best of the 25 forms described in the volume. Other forms such as *D. aequus* Ni are similar but have wider stipes proximally or fewer thecae per cm. This species has the initial dorsal curvature of the stipe characteristic of *Corymbograptus* although many of the other 'deflexed' forms do not. The sicula appears to be distinctly curved towards the second stipe, a feature also noted by the Chinese workers for *C. deflexus* although not particularly noticable in Elles & Wood's (1901) figures. All the Chinese deflexed forms are from the *deflexus* Zone, well below their *hirundo* horizon, and this would confirm the suggestion above (p. 4) that the Shelve Church Beds of the Mytton Member are not as late as the *hirundo* Zone, although some workers have claimed this.

Subfamily **ISOGRAPTINAE** Harris, 1933

Genus ***ISOGRAPTUS*** Moberg, 1892

TYPE SPECIES. *Didymograptus gibberulus* Nicholson 1875.

Isograptus sp.
Fig. 13; Pl. 1, fig. 8

DESCRIPTION. A single specimen in the Whittard Collection (Q.5247) is a broken but well-preserved isograptid which cannot be matched with any described form. The sicula is 3 mm long with a further 2·5 mm of nema. The first theca is almost as long as the sicula and diverges from it only in the last part, leaving a deep notch between the two which is emphasized by the long stout processes on both (and on all the subsequent thecae). The width of the stipes at the flexure is 2·0 mm but they seem to narrow distally, a real narrowing since the apertural processes are present. The dorsal curvature of the stipes is asymmetrical in relation to the sicula but is comparatively gentle, suggesting an angle of 120° (240° between the ventral margins), a much greater angle of divergence than in most species of *Isograptus*. The longer of the two stipes is only 5 mm but there are 9 thecae, a much closer arrangement than in any described species.

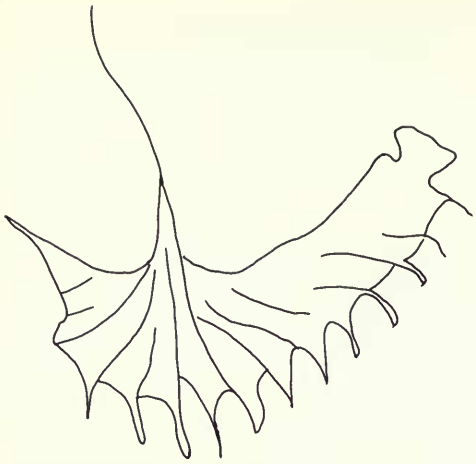


Fig. 13 *Isograptus* sp. Q.5247, Loc. 791. Drawing of Pl. 1, fig. 8, × 10.

DISCUSSION AND OCCURRENCE. Jenkins (1982) has attempted a redefinition of *Isograptus* but unfortunately he states that Moberg's original description was based on material from Öland when in fact all the figures are material from Killeröd which Jenkins claims is a different form. None of the forms which Jenkins figures from Britain bear any close resemblance to this single specimen from Shelve which unfortunately was found by itself at Loc. 791, mapped by Whittard as Mytton Member. There is no counterpart so details of proximal development are incomplete.

Subfamily **SIGMAGRAPTINAE** Cooper & Fortey, 1982

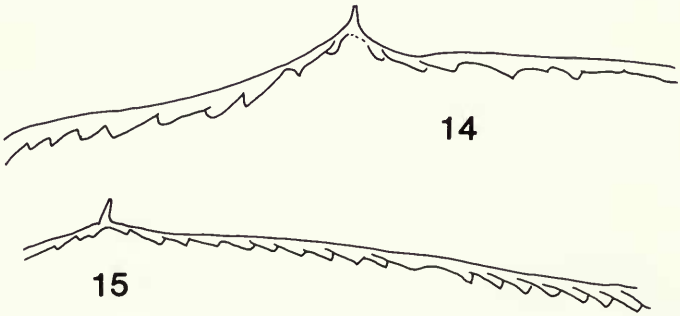
Genus ***ACROGRAPTUS*** Tzaj, 1969

TYPE SPECIES. *Didymograptus affinis* Nicholson 1869.

Acrograptus acutidens (Elles & Wood 1901)
Figs 14, 15; Pl. 2, figs 3, 4

1901 *Didymograptus acutidens* Lapworth MS; Elles & Wood: 25; pl. 2, figs 3a–d; text-figs 15a–c.

DESCRIPTION. Stipes straight, several cm long with a maximum width of 1 mm. Sicula prominent, about 1 mm long, the first thecae diverging from its aperture at about 150°; the width at th1[1] is 0·3 mm. Thecae 13 per cm, inclined at 20° to the stipe length and with considerable overlap distally.



Figs 14, 15 *Acrograptus acutidens* (Elles & Wood). Fig. 14, Q.5248, Loc. 54; Fig. 15, Q.5249, Loc. 701, drawing of Pl. 2, fig. 4. Both × 5.

DISCUSSION. Tzaj (1969) included this slender species in his original account of *Acrograptus* although the stipes are nearly horizontal. The species is one of Lapworth's MS forms from Shelve and was first described by Elles & Wood. The specimens are not well enough preserved to show details of development as there seems to be some thickening around the proximal end. One specimen (Fig. 14) shows similar slender stipes with greater proximal curvature approaching that seen in *E. nitidus*.

MATERIAL AND HORIZON. The species occurs in the Hope Member. Q.5248, Loc. 54; Q.5249, Loc. 701; Q.5250, Q.5251, Loc. 834N.

Acrograptus gracilis (Törnquist 1890)
Figs 16, 17

1890 *Didymograptus gracilis* Törnquist: 17; pl. 1, figs 9–12.
1901 *Didymograptus gracilis* Törnquist; Elles & Wood: 24; pl. 2, fig. 2; text-figs 14a, b.
1982 *Acrograptus gracilis* (Törnquist); Cooper & Fortey: 272; figs 66c–g.

DESCRIPTION. Stipes up to 1 cm long, very slender, widening from 0·3 mm to 0·5 mm. Sicula long and slender, initial bud appearing in upper half. First two thecae turning laterally at the sicular aperture and soon extending horizontally. Thecae long and slender, about 11 per cm, overlapping about one third, with simple apertures.

DISCUSSION. This very slender species was included in the original account of *Acrograptus* (Tzaj 1969), although the stipes extend horizontally. As with *A. acutidens*, the proximal end is clearly different from the *Expansograptus* type and these generally slender forms may well be phylogenetically related with the stipe attitude variable.

MATERIAL AND HORIZON. The species is rare in the Hope Member but the slender stipes are easily overlooked. Q.5252, Loc. 54; Q.5253, Loc. 58.

Figs 16, 17 *Acrograptus gracilis* (Törnquist). Fig. 16, impression of reverse view, Q.5252a; Fig. 17, counterpart showing impression of obverse view, Q.5252b. Both Loc. 54, × 5.

Family **GLOSSOGRAPTIDAE** Lapworth, 1873

Genus ***GLOSSOGRAPTUS*** Emmons, 1855

TYPE SPECIES. *Glossograptus ciliatus* Emmons 1855.

Surprisingly, only three specimens of this genus have been found in the Whittard Collection. Whittard recorded *G.* cf. *acanthus* in his 1931 paper but the genus does not seem to have been recorded elsewhere from Shelve. *G. hincksi* has been used as a zonal index in Scandinavia and is quite common in the Ordovician of the south of Scotland and in Ireland, so its absence from the Welsh Borders is unexpected. Some 30 species and subspecies have been described to date, but the known complexity of the spines and other processes allows differing views of the same specimen to appear quite different, and it is probable that many of the described forms are synonyms.

Glossograptus cf. *acanthus* Elles & Wood 1908
Fig. 18; Pl. 2, fig. 17

cf. 1908 *Glossograptus acanthus* Elles & Wood: 314; pl. 33, figs 4a–c; text-figs 208a, b.

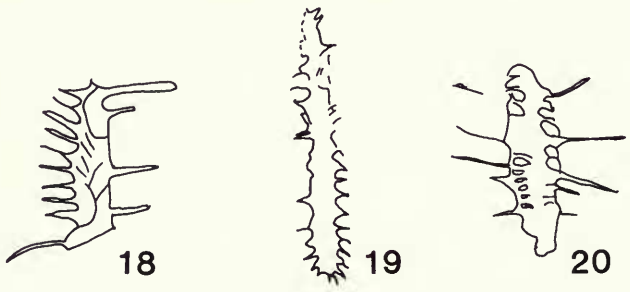
A single distal fragment appears to belong to this species (Q.5254). The specimen is 8 mm long and the width of 2 mm, excluding the spines, is rather narrow for *G. acanthus* but the stout

thecal spines suggest that species. The more distantly placed septal spines project at right angles to the rhabdosome and are also long (up to 4 mm) and stout. This view, showing thecal spines on one side and septal spines on the other, is one which is not illustrated by Elles & Wood but shown by Hadding (1915: pl. 5, fig. 6) for *G. hincksi* and was the basis of his reconstruction of the rhabdosome as a monopleural series. Other authors, however, have not figured the septal spines in this species. *G. minor* Mu, Geh & Yin 1962 is known only as proximal ends up to 6 mm long and there is no information on septal spines, but its general size and thecal type are similar to the specimen here. In *G. holmi*, Bulman (1931: 69) specifically notes that the biprofile width is 3–4 mm but in scalariform view the width is only 2·5 mm. The relative narrowness of this specimen compared with Elles & Wood's range for the species may result from the different preservational view. The thecal count, 12 per cm, is slightly higher than the figure given by Elles & Wood (10 per cm) but their plate shows specimens with more than 10. The horizon, Stapeley Member (Loc. 132), is right for this species.

Glossograptus fimbriatus (Hopkinson 1872)
Fig. 19; Pl. 2, fig. 16

1872 *Diplograptus fimbriatus* Hopkinson: 506; pl. 12, fig. 8.

A second single specimen (Q.5255) from the Stapeley Member (Loc. 133) is a more or less complete rhabdosome about 14 mm long, in biprofile view. The thecae number 14 per cm and are provided with short but stout recurved processes up to 1 mm long. The width, excluding the spines, is 1·6 mm. The distal part is poorly preserved and details of the proximal end are difficult to interpret. There seems to be a long central sicula but the rest of the proximal thecae can only be traced from the apertural spines which point downwards. In general size and form, it matches the specimen figured by Elles (1898) from the Skiddaw Slates, an earlier horizon than that from which Hopkinson originally described the species. Mu & Lee (1958) figured the species with similar dimensions from the Ningkuo Shale (*Expansograptus hirundo* Zone), so the species appears to have a long range.



Figs 18–20 *Glossograptus* spp. Fig. 18, *G.* cf. *acanthus* Elles & Wood. Q.5254, Loc. 132 (Pl. 2, fig. 17). Fig. 19, *G. fimbriatus* (Hopkinson). Q.5255, Loc. 133 (Pl. 2, fig. 16). Fig. 20. *G.* cf. *armatus* (Nicholson). Q.5256, Hope Member, exact locality unknown (Pl. 2, fig. 15). All $\times 2\frac{1}{2}$.

Glossograptus cf. *armatus* (Nicholson 1869)
Fig. 20; Pl. 2, fig. 15a, b

cf. 1869 *Diplograpsus armatus* Nicholson: 234; pl. 11, fig. 8.
cf. 1908 *Glossograptus armatus* (Nicholson) Elles & Wood: 312; pl. 33, figs 5a–e, text-fig. 207.

The third glossograptid from Shelve is from the lower horizon of the Hope Member (Q.5256, Illing Collection) and is a slightly sheared specimen showing very long, stout septal spines. Traces of the thecae can be seen, some of which bear shorter spines. The proximal end is damaged. The rhabdosome is 10 mm long and has a width of 2·4 mm exclusive of the long spines, which can reach a length of 3·5 mm. Nicholson's original description was based on poorly preserved material but Elles' (1898) account seems to be too restrictive as to size. The

later description in the Monograph (Elles & Wood 1908) is largely based on younger Scottish specimens and lays particular emphasis on the long proximal spines. These are well shown on Chinese specimens assigned to this species (Mu *et al.* 1962), where they are described as up to 7 mm long. The thecal count is given as 6 to 7 in 5 mm, which agrees with my estimate of the Shelve specimen and is higher than the figure given by Elles & Wood (9 per cm).

Genus ***CRYPTOGRAPTUS*** Lapworth, 1880

TYPE SPECIES. *Diplograpsus tricornis* Carruthers 1858.

Recent work on the proximal end of *C. tricornis* shows that *Cryptograptus* has the same general development as *Glossograptus* and so the two genera can be kept in the same family (Strachan 1985).

Cryptograptus tricornis (Carruthers 1858)
Pl. 6, fig. 7

1858 *Diplograpsus tricornis* Carruthers: 468, text-fig. 2.
1969 *Cryptograptus tricornis* (Carruthers); Strachan: 194; pl. 4, figs 4–6; text-fig. 3c (with synonymy).

DISCUSSION. A number of specimens from the Aldress Member show the characteristic features of this species. The rhabdosome is widest at the proximal end (about 1·2 mm) and generally tapers distally. The thecae number 12 per cm and some of the specimens show the basal spines clearly. A few slabs have the surface crowded with specimens but the species is more usually represented by single specimens at each locality.

MATERIAL. Q.5257, Loc. 343; Q.5258, Loc. 395; Q.5259, Loc. 355.

Cryptograptus schaeferi Lapworth 1880
Fig. 21; Pl. 3, fig. 6

1880 *Cryptograptus tricornis* var. *Schaeferi* Lapworth: pl. 5, figs 5a, b.
1908 *Cryptograptus tricornis* var. *Schäferi* Lapworth; Elles & Wood: 299; pl. 32, figs 13a–c; text-figs 201a, b.
cf. 1970 *Cryptograptus tricornis schaeferi* Lapworth; Skevington: 418; text-figs 6a–h, 7a–d.

A few specimens of *Cryptograptus* occur in the Meadowtown Member: Q.5260, Loc. 329; Q.5261, Loc. 503. They are not well preserved but none show the characteristic basal spines of *C. tricornis*; instead the few proximal ends in profile view show rather broad processes from the basal thecae. The rhabdosome has a width of about 1·5 mm and the thecae number about 15 per cm proximally, agreeing with Skevington's (1970) account of this species. Some of Skevington's specimens show long basal spines but none of Lapworth's original material from Builth shows this view. It is therefore possible that the material from the Lake District, which is from an earlier horizon in any case, is distinct from the typical *C. schaeferi.* The stratigraphically early records of '*C. tricornis*' are certainly all suspect but they may not all be *C. schaeferi* as Skevington has suggested. It is noteworthy that the genus does not seem to occur in the Shelve district before the Meadowtown Member which, on the basis of its general fauna, cannot be

Fig. 21 *Cryptograptus schaeferi* Lapworth. Q.5260, Loc. 329. Small proximal end, × 5.

older than Llandeilo. Finney (1978), in a discussion of the affinities of *Cryptograptus*, has put *C. schaeferi* as a junior synonym of *C. marcidus* (Hall) but has not designated type material for *marcidus*. Hall's original drawings (1859) include forms with typical *tricornis* basal spines which have led most workers since Carruthers (1858) to include *marcidus* as a junior synonym of *tricornis*.

Family **CORYNOIDIDAE** Bulman, 1945

Genus ***CORYNOIDES*** Nicholson, 1867

TYPE SPECIES. *Corynoides calicularis* Nicholson 1867.

Corynoides cf. ***curtus*** Lapworth 1876

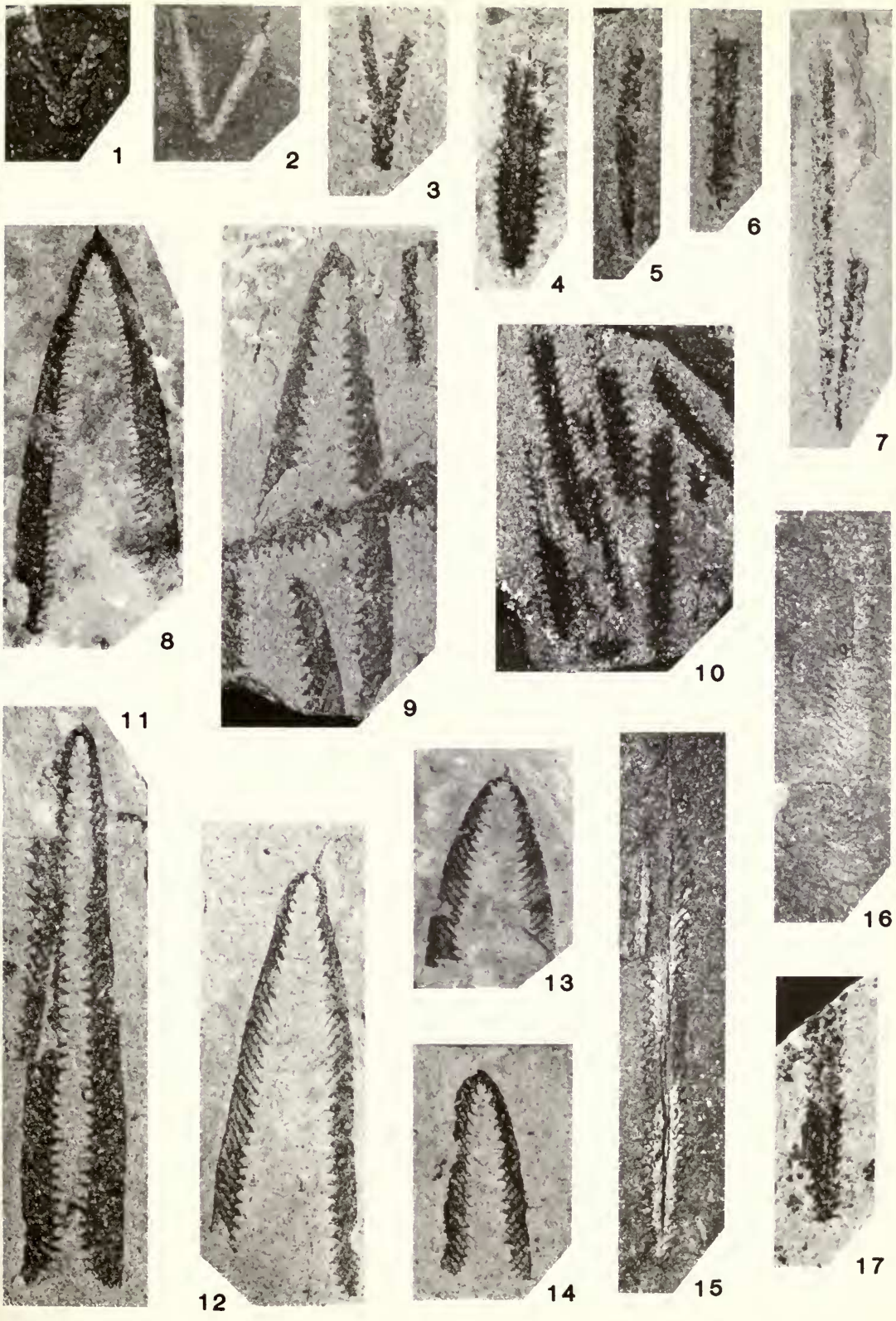
cf. 1876 *Corynoides curtus* Lapworth: pl. 4, fig. 92.
cf. 1949 *Corynoides curtus* Lapworth; Strachan: 157, text-figs 2a–g.

DESCRIPTION. Rhabdosome 6–8 mm long, 0·6 mm wide, consisting of a long sicula and one or two thecae, all poorly preserved.

DISCUSSION. A single slab of Aldress Shales (Q.5262, Loc. 355) is crowded with specimens which are clearly *Corynoides* associated with *Climacograptus*. They agree in size with *C. curtus*, rather than *C. calicularis* which is considerably longer. Riva (1974) suggested that the two forms should be regarded as the same but he has clearly misunderstood the characters of the genus and the differences in aspect between the two forms. Since Ruedemann's (1947) figures of American material are apparently unreliable (*fide* Riva 1974: 37), further work is necessary beyond the comparisons which I made in 1949. It seems unwise to restrict *C. americana* Ruedemann to forms which have only one fully-developed theca since the specimens in one swarm are often juveniles at the same stage of development.

PLATE 3 Figs 1–7 from Meadowtown Member; Figs 8–12, 15–17 from Betton Member; Figs 13, 14 from Weston Member.

Fig. 1 *Dicranograptus irregularis* Hadding, p. 32. Q.5286, Loc. 144. × 6. See also Text-fig. 29, p. 33.
Fig. 2 *Dicellograptus sextans* (Hall), p. 29. Q.5272, Loc. 324. × 3. See also Text-fig. 22, p. 30.
Fig. 3 *Dicranograptus* sp., p. 34. Q.5292, Loc. 314. × 3.
Fig. 4 *Diplograptus foliaceus* (Murchison), p. 34. Q.5293, Loc. 563. × 3. See also Pl. 6.
Fig. 5 *Climacograptus* cf. *brevis* Elles & Wood, p. 42. Q.5329, Loc. 314. × 3. See also Pl. 5.
Fig. 6 *Cryptograptus schaeferi* Lapworth, p. 25. Q.5261, Loc. 503. × 3.
Fig. 7 *Climacograptus* aff. *antiquus lineatus* Elles & Wood, p. 41. Q.5325, Loc. 957A. × 3. See also Pl. 6.
Figs 8, 9 *Didymograptus murchisoni* (Beck), p. 12. Fig. 8, BU.2080 (E. M. R. Wood collection), Holywell Brook. × 2. Fig. 9, Q.5209, Loc. 382A. × 3.
Fig. 10 *Gymnograptus* (?) sp., p. 47. Q.5338, Loc. 234. × 3. See also Text-fig. 39, p. 47.
Figs 11–14 *Didymograptus murchisoni* (Beck), p. 12. Fig. 11, Q.5210, Loc. 307. Fig. 12, Q.5211, Loc. 437. Fig. 13, Q.5212, stream junction W of Lyde. Fig. 14, Q.5213, Loc. 444. All × 3.
Figs 15, 16 *Gymnograptus* (?) sp., p. 47. Betton Dingle. Fig. 15, BU.2081 (Lapworth Collection). Fig. 16, BU.2082 (J. T. Wattison Collection). See also Text-fig. 40, p. 47. Both × 3.
Fig. 17 *Diplograptus foliaceus* (Murchison), p. 34. Q.5294, Loc. 575A. × 3. See also Pl. 6.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Family NEMAGRAPTIDAE Lapworth, 1873

Genus *NEMAGRAPTUS* Emmons, 1855

TYPE SPECIES. *Graptolithus gracilis* Hall 1848.

Nemagraptus gracilis (Hall 1847)
Pl. 4, fig. 8

1847 *Graptolithus gracilis* Hall: 274; pl. 74, figs 6a–d.
1903 *Nemagraptus gracilis* (Hall) Elles & Wood: 127; pl. 19, figs 1a–f; text-figs 76a–c.
1977 *Nemagraptus gracilis* (Hall); Finney: 121.

DISCUSSION. This widely recorded species and its varieties have been discussed in some detail by Finney (1977) but I cannot agree with him that the various appearances of the different forms are entirely due to differences of preservation of a single form. The Shelve specimens, although well preserved, are not easy to study since most are fragmentary and not exposed on single bedding planes. The typical S-shape of the rhabdosome is often clearly shown and the secondary stipes appear to arise from successive thecae of the primary stipes. The width of the branches seems to be never more than 0·4 mm while the primary stipes are only 0·3 mm. Most of the specimens are at least in semi-relief, which would account for their relative narrowness.

MATERIAL AND HORIZON. The species is widespread in the Rorrington Member but does not occur in either the beds above or below. Q.5263, Loc. 371; Q.5265, Loc. 594; Q.5266, Loc. 956.

A single specimen (Q.5264, Loc. 493) from the Rorrington Member shows much more widely spaced branches and may be referable to *N. gracilis distans* Ruedemann, but it is too incomplete for real determination (Pl. 4, fig. 4).

Genus *LEPTOGRAPTUS* Lapworth, 1873

TYPE SPECIES. *Graptolithus flaccidus* Hall 1865

Leptograptus validus Elles & Wood 1903
Pl. 4, figs 7, 9

1903 *Leptograptus validus* Lapworth MS; Elles & Wood: 113; pl. 16, figs 1a–e; text-figs 68a, b.

DESCRIPTION. Stipes often long, more than 10 cm long, but comparatively slender, the maximum width being 1·0 mm when compressed. The initial width of the stipes is about 0·4 mm and the increase is slow so that the stipes frequently only measure 0·7–0·8 mm wide in the distal parts. The sicula is generally prominent and is about 1·3 mm long. The first two thecae grow obliquely downwards and outwards from the level of the sicular aperture, so that it is generally hidden and there is only occasionally any sign of a virgella. The stipes then grow slightly upwards so that the later thecae are horizontal. There are no spines on the proximal thecae and the ventral walls of the later thecae are straight. The thecae number 10 to 12 per cm.

DISCUSSION. This Lapworth manuscript species was described by Elles & Wood as being abundant in the beds above the *Nemagraptus* Beds in Spy Burn and thus appears to be the form which Lapworth regarded as characterizing his 'Leptograptus Beds'. The species occurs commonly in the Rorrington Member and most of the localities in Whittard's collection yield *Nemagraptus* as well, e.g. Loc. 352. The few localities without *Nemagraptus* (e.g. Locs 373 and 374) are in what Whittard regarded as the highest part of the Rorrington Member, but are apparently succeeded by another locality, Loc. 371, in which both *L. validus* and *N. gracilis* occur. It is therefore doubtful if Lapworth's division of the Rorrington Flags into *Nemagraptus* and *Leptograptus* horizons can be maintained as a stratigraphic sequence.

MATERIAL AND HORIZON. Rorrington Member: Q.5267, Loc. 352; Q.5268, Loc. 374; Q.5263, Loc. 371.

Leptograptus latus Elles & Wood 1903
Pl. 5, fig. 4

1903 *Leptograptus latus* Elles & Wood: 116; pl. 16, figs 5a–e; text-figs 71a, b.

LECTOTYPE. Specimen GSM 49763 (British Geological Survey), figured by Elles & Wood (1903: pl. 16, fig. 5c), is here selected as being the best of the original figured specimens and the one which was also figured as text-fig. 71a.

DISCUSSION. This species has not been found in the Whittard Collection although it was originally described from the Shelve area, Rorrington Member. It is characterized by the more rapid widening of the stipes from an initial 0·4 mm to over 1 mm distally and the greater number of thecae, 12 to 14 per cm when compared with *L. validus*. It is included here for completeness.

Family **DICRANOGRAPTIDAE** Lapworth, 1873

Genus ***DICELLOGRAPTUS*** Hopkinson, 1871

TYPE SPECIES. *Didymograpsus elegans* Carruthers 1867.

Dicellograptus divaricatus (Hall 1859)
Pl. 4, fig. 1

1859 *Graptolithus divaricatus* Hall: 513; figs 3, 4.
1904 *Dicellograptus divaricatus* (Hall); Elles & Wood: 143; text-figs 87b, c.

DESCRIPTION. Stipes up to several cm long, diverging from a rounded axil at 50° to 70°, slender at first (0·6 mm) but widening in the first 10 mm to about 1 mm which is then maintained. Thecae about 11 per cm, with curved ventral walls, apertures opening into deep excavations which occupy up to half the width of the stipe and two-fifths of the free ventral length of the thecae. The first few thecae on each stipe bear prominent mesial spines but later thecae have only slightly curved supragenicular walls.

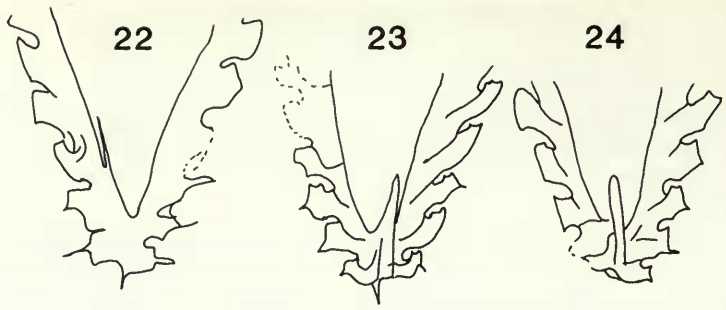
DISCUSSION. Hall's original description of this species (1859) included a wide range of axial angle and stipe curvature but later workers have generally accepted the restriction of the species to forms with straight stipes diverging at about 60°–70°. Hall (1865: 14) later notes that *D. sextans* differs in having the branches united for the first pair of thecae, while in *D. divaricatus* the branches are entirely separate. This, however, is not quite so clear when typical specimens are examined. In both forms, the sicula is generally incorporated into one of the stipes, leading to a compact proximal end. The axil in *D. divaricatus*, however, always seems to be more rounded.

MATERIAL AND HORIZONS. A single specimen, Q.5270, has been found in the Meadowtown Member, Loc. 164, and the species also occurs in the Rorrington Member (Q.5269, Loc. 497; Q.5271, Loc. 390) but it is not common. Elles & Wood recorded it doubtfully from Spy Burn, a stream which exposes a section from Betton Member to Aldress Member, but their other records from Spy Burn include *Didymograptus superstes* and *Nemagraptus gracilis* so it appears that the Rorrington Member is the horizon intended.

Dicellograptus sextans (Hall 1847)
Figs 22–24; Pl. 3, fig. 2; Pl. 4, fig. 2

1847 *Graptolithus sextans* Hall: 273; pl. 74, fig. 3.
1904 *Dicellograptus sextans* (Hall); Elles & Wood: 153; pl. 21, figs 1a–c; text-figs 96a, b.

DESCRIPTION. Stipes generally up to 1 cm long but may reach 2·5 cm, diverging at 40° to 60°, straight; width 0·6 mm at proximal end but widening rapidly to 0·8 or 0·9 mm which is then maintained; thecae about 12 per cm, occasionally closer; proximal two or three on each stipe



Figs 22–24 *Dicellograptus sextans* (Hall). Fig. 22, Q.5272, Loc. 324. Proximal part of Pl. 3, fig. 2, showing sicula almost totally incorporated in the second stipe. Fig. 23, Q.5273, Loc. 377. Sicula partially incorporated. Fig. 24, Q.5274, Loc. 497. Proximal part of Pl. 4, fig. 2 showing the free sicula. All × 10.

with stout mesial spines, later thecae simply with convex ventral walls becoming straight distally; apertures introverted, opening into deep and fairly wide excavations occupying about half the width of the stipe and a quarter of the total length of the thecae. The position of the sicula is variable, being free, more or less inclined or even incorporated into one stipe. Its length is about 1·5 mm and there is a prominent but short virgella.

Discussion. In the absence of any modern redescription of Hall's species, I have taken forms similar to those figured by Elles & Wood as being typical of the species. The main differing feature of the Shelve specimens is the appearance of the sicula. Elles & Wood (1904) give its length as 0·7 mm and say that it never appears conspicuously in the axil. The two specimens figured here showing the sicula in the axil have all the other characters of *D. sextans* (and of no other described form). The length of the sicula agrees with at least one of the specimens figured by Elles & Wood although it is not easy to obtain the exact figure when the apex of the sicula is incorporated into a stipe.

Material and horizons. Rorrington Member: Q.5273, Loc. 377; Q.5274, Loc. 497. Topmost Meadowtown Member: Q.5272, Loc. 324; Q.5275, Loc. 164.

Dicellograptus intortus Lapworth 1880
Fig. 25; Pl. 4, fig. 3

1880 *Dicellograptus intortus* Lapworth: 161; pl. 5, fig. 19a.
1904 *Dicellograptus intortus* Lapworth; Elles & Wood: 146; pl. 20, figs 4a–f; text-figs 90a–d.

Description. The proximal end of this species shows considerable variation in appearance in differing views. The stipes are twisted distally but rarely show crossing of the stipes (cf. Williams 1981). The whole rhabdosome, however, is occasionally found in a side view with the stipes more or less overlapping. Stipes up to 18 mm long, initial width 0·4 mm, widening steadily to a maximum of about 0·8 mm. The axillary angle is small, 20° to 25°, and the first two pairs of thecae form a compact proximal end approaching the dicranograptid state. The proximal four or five thecae on each stipe bear stout mesial spines and the apertures open into deep excavations. Owing to the twisting of the stipes, profile views of the distal thecae are rare.

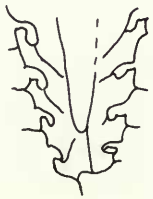


Fig. 25 *Dicellograptus intortus* Lapworth. Q.5276, Loc. 390. Enlargement of proximal part of Pl. 4, fig. 3, × 10.

DISCUSSION. Erdtmann (1976) has put *D. smithi* Ruedemann into synonymy with *D. intortus*, but the latter seems to have fewer spined thecae. Obut & Sobolevskaya (1964: pl. 5, fig. 2) figure a specimen as *D. intortus*, but it again seems to have mesial spines on fairly distal thecae. Clearly much further study of these forms is required.

MATERIAL AND HORIZONS. The species is common at a few localities in the Rorrington Member: Q.5276, Loc. 390; Q.5278, Loc. 389; Q.5355, Loc. 374. A single specimen, Q.5277, attributed to this species, occurs in the succeeding Spy Wood Member, Loc. 394.

Dicellograptus salopiensis Elles & Wood 1904
Fig. 26; Pl. 4, fig. 6

1904 *Dicellograptus divaricatus* var. *salopiensis* Elles & Wood: 145; pl. 20, figs 7a–c, e; text-figs 89a, b.

DESCRIPTION. Stipes up to 2 cm long, with a constant width of 0·6 mm, diverging at 60° to 80°; thecae 14 to 12 per cm, with curved ventral walls, the proximal thecae bearing stout mesial spines; apertures opening into deep but narrow excavations which occupy about a quarter of the length of the theca. Sicula 1·8 mm long, incorporated into the second stipe, virgella prominent.

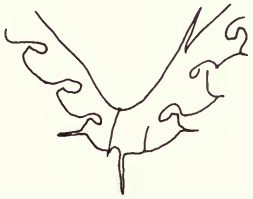


Fig. 26 *Dicellograptus salopiensis* Elles & Wood. Q.5279, Loc. 479. Enlargement of proximal part of Pl. 4, fig. 6, × 10.

DISCUSSION. Elles & Wood distinguished this form as a variety of *D. divaricatus* on its more slender stipes. It has been much more widely recorded by later workers than *D. divaricatus* itself and seems worthy of recognition as a full species, pending a complete review of the genus. The subdivision into four groups by Elles & Wood cannot be used when *salopiensis* as a variety of *divaricatus* is in a different group from *sextans*, whose variety *exilis* is very close to *salopiensis* (see below).

MATERIAL AND HORIZON. *D. salopiensis* is widely distributed in the Rorrington Member (e.g. Q.5279, Loc. 479) but is not common at any locality.

Dicellograptus exilis Elles & Wood 1904
Pl. 4, fig. 5; Pl. 5, fig. 13.

1904 *Dicellograptus sextans* var. *exilis* Elles & Wood: 155; pl. 21, figs 2a–d; text-fig. 97.

DESCRIPTION. Stipes up to 3·5 cm, straight, diverging at 30° to 50°, width almost uniform, 0·3–0·5 mm. Thecae 13 to 14 per cm, the first four or five on each stipe bearing mesial spines. Sicula apparently incorporated into one stipe.

DISCUSSION. Erdtmann (1976) has put *exilis* into synonymy with *salopiensis* but the two forms seem to be distinct in the Shelve area, *D. exilis* being distinguished by its narrower stipes and narrower axil.

MATERIAL AND HORIZONS. Specimens referred to *D. exilis* are rare in the Rorrington Member (Q.5280, Loc. 493), and a single specimen has been found in the succeeding Spy Wood Member (Q.5281, loc. unknown).

Dicellograptus cf. ***vagus*** Hadding 1913

cf. 1913 *Dicellograptus vagus* Hadding: 53; pl. 4, figs 15–19.

DESCRIPTION. Stipes 17 mm long, width almost uniform, 0·6–0·7 mm; thecae 13 per cm, similar to those of *D. sextans*. Stipes diverging at 25°.

Discussion. A single specimen (Q.5282) from the Meadowtown Member (Loc. 503) appears to be fairly close to *D. vagus* although the sicula is not conspicuous. The specimen is poorly preserved but the stipes do not seem to show the twisting characteristic of *D. intortus*. The occurrence of three different forms of *Dicellograptus* in the Meadowtown Member is interesting. Toghill (1970) has described *D.* cf. *vagus* from the Hendre Shales of south Wales on the same horizon as at Shelve and Berry (1964) figured it from Norway, but in both cases no other species of *Dicellograptus* is recorded from the same horizon.

Genus ***DICRANOGRAPTUS*** Hall, 1865

Type species. *Graptolithus ramosus* Hall 1847.

Elles & Wood (1904) subdivided the genus into four groups based on distal thecal characters, but examination of some of their figured specimens does not uphold some of the distinctions. As with *Dicellograptus*, it seems best to leave the genus undivided until the species all receive modern critical re-examination.

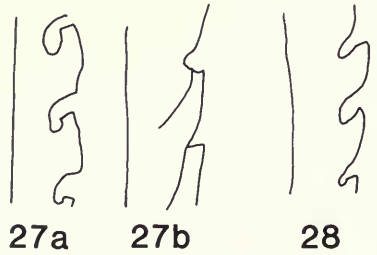
Dicranograptus brevicaulis Elles & Wood 1904
Fig. 27; Pl. 5, fig. 2

1904 *Dicranograptus brevicaulis* Elles & Wood: 168; pl. 24, figs 3a–d, text-fig. 105.

Description. Biserial portion very short, about 3 mm long, consisting of 4 or 5 pairs of thecae and widening from 0·8 mm to 1·6 mm at the axil. Branches uniformly 0·8 mm wide, diverging at 25° to 30° and 25 mm or more long. Proximal thecae apparently all spined up to the base of the branches. Thecae 14 to 12 per cm, apertures introverted, opening into deep excavations.

Discussion. The main distinguishing feature of *D. brevicaulis* from the accompanying *D. rectus* appears to be the length of the biserial portion, although the spines seem to be less well developed in *brevicaulis*. Their appearance, however, is very dependant on the state of preservation and specimens in full relief (?pyritic internal casts) show few traces of spines.

Material and horizon. The species is fairly widespread in the Rorrington Member and is common at a few localities, e.g. Q.5284, Loc. 334; Q.5285, Loc. 371; Q.5283, Loc. 374.

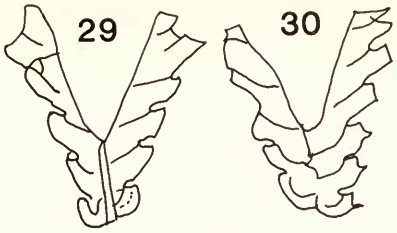


Figs 27, 28 *Dicranograptus* spp., uniserial stipes. Fig. 27, *D. brevicaulis* Elles & Wood. a, proximal and b, distal parts of Q.5284, Loc. 334, showing variation in appearance. Fig. 28, *D. rectus* Hopkinson. Q.5289, Loc. 956. Enlargement of part of Pl. 5, fig. 1. All × 10.

Dicranograptus irregularis Hadding 1913
Figs 29, 30; Pl. 3, fig. 1

1913 *Dicranograptus irregularis* Hadding: 52; pl. 4, figs 1–12.

Description. Biserial portion very short, about 1 mm long, consisting of 2 or 3 pairs of thecae which are markedly alternate. The width increases from about 1 mm to 1·5 mm where the uniserial stipes diverge at an angle of 40° to 60°. These are up to 6 mm long and have a breadth of 0·6–0·8 mm. Thecae are closely spaced, about 16 per cm, and have slightly introverted apertures opening into narrow excavations. The sicula appears to be the full length of the biserial portion and is exposed for the whole of the obverse view in several specimens.



Figs 29, 30 *Dicranograptus irregularis* Hadding. Fig. 29, obverse view showing sicula, Q.5286. Fig. 30, reverse view, Q.5287. Both Loc. 144, ×10.

Discussion. Hadding's enlarged figures show spines on only the basal pair of thecae at most, but the Shelve material shows a greater development of spines; in a few specimens all the thecae bear spines.

Material and horizon. The species is rare and is confined to the Meadowtown Member: Q.5286, Q.5287, Loc. 144; Q.5288, Loc. 324; Q.5357, Loc. 503.

Toghill (1970) has figured a possible specimen of the species from the Hendre Shales and Berry (1964) has described specimens from Norway from the *Didymograptus murchisoni* Zone, marginally earlier than the Shelve occurrence.

Dicranograptus rectus Hopkinson 1872
Fig. 28; Pl. 5, figs 1, 3, 11

1872 *Dicranograptus rectus* Hopkinson: 508; pl. 12, fig. 10.
1904 *Dicranograptus rectus* Hopkinson; Elles & Wood: 169; pl. 24, figs 4a–e; text-figs 106a, b.

Description. Biserial portion short, about 5 mm long, consisting of 7 or 8 pairs of thecae and widening from 0·8 mm at the proximal end to 2·0 mm at the axil. Uniserial branches up to 10 cm long or more, diverging at 25° to 30°, with a uniform width which varies from 0·6 mm to 1·0 mm depending on the state of preservation. Thecae closely set on the biserial portion (15 per cm) but more widely spaced on the branches (10 per cm). All the biserial thecae bear prominent mesial spines and these are also seen on the first few thecae of the branches. The more distal thecae appear to have straight ventral walls and the thecal apertures open into deep excavations.

Discussion. The species is distinguished by the comparatively short biserial portion which is also very spiny and by the fact that the ventral margin of each branch forms nearly a straight line with the biserial portion. This was Hopkinson's original criterion by which he distinguished *rectus* from his earlier-described *D. nicholsoni*. In the original description Hopkinson gives the length of the biserial portion as $\frac{1}{10}$ to $\frac{1}{5}$ of an inch (2·5–5 mm), but Elles & Wood give this figure as 6–8 mm, presumably putting the shorter forms into their new species *D. brevicaulis*. One of their figured specimens of *D. brevicaulis* (1904: pl. 24, fig. 3b) is at any rate originally labelled *D. rectus* and would appear to be better placed there. Elles & Wood, however, put the two species into different groups of the genus, based on the distal thecal shape, but examination of some of the figured material does not substantiate the criteria for separating the groups. The apertures in both *D. brevicaulis* and *D. rectus* are strongly introverted, opening into deep pouch-like excavations. The difference between the species then appears to be mainly the length of the biserial portion, but there are not enough specimens in the present material to provide any real measure of the range present. Other short-stemmed species such as *D. hians* T. S. Hall can be distinguished by the much greater angle of divergence of the branches.

Material and horizons. *D. rectus* is a rare species occurring in the Rorrington Member: Q.5289, Loc. 956; Q.5290, Loc. 373. One specimen has been found in the succeeding Spy Wood Member: Q.5291, Loc. 417A.

Dicranograptus sp.
Pl. 3, fig. 3

A single specimen, Q.5292, from the Meadowtown Member, Loc. 314, has a biserial portion 4 mm long with a width of 1·0–1·6 mm, and short (6 mm) branches which are 0·8 mm wide. Thecae number about 15 per cm. The first two thecae show traces of spines, but none of the later thecae have them although the preservation ought to show them if present. In general dimensions and shape it is similar to *D. rectus* but the absence of spines precludes that species. It is also similar to *D. clingani* but the horizon is far too low for that species. There are traces of a structure (?virgula) between the two branches, and it is possible that the specimen is a split diplograptid such as has been found in the Lower Silurian (Williams 1983: text-fig. 3b).

Family **DIPLOGRAPTIDAE** Lapworth, 1873

Genus ***DIPLOGRAPTUS*** M'Coy, 1850

TYPE SPECIES. *Graptolithus foliaceus* Murchison 1839.

Diplograptus foliaceus (Murchison 1839)
Pl. 3, figs 4, 17; Pl. 6, figs 10, 11

1839 *Graptolithus foliaceus* Murchison: 694; pl. 26, figs 3, 3a.
1907 *Diplograptus* (*Mesograptus*) *foliaceus* (Murchison); Elles & Wood: 259; pl. 31, figs 8a–f, text-figs 177a–d.

DESCRIPTION. Rhabdosome up to 3 cm long, widening from 0·8–1·0 mm at th1[1] to 1·6–2·0 mm at 5 mm, and to a maximum of about 3·0 mm. Thecae usually 8 to 9 in the first 5 mm, 12 to 14 per cm distally, proximal thecae climacograptid with rather shallow excavations occupying up to a quarter of the width of the rhabdosome and a third of the free ventral edge, distal thecae becoming orthograptid after about the first 10 mm, th1[1] and 1[2] with subapertural spines; virgella slender.

DISCUSSION. Elles & Wood (1907) commented on the confusion that surrounded this name in the 19th century and provided the first good account. It is surprising, therefore, that they did not give any good comparison with their new species *D. multidens*, simply implying that the latter was broader and had more numerous thecae. Re-examination of the illustrations and specimens of *foliaceus* shows that its proximal thecal count is as high as that for *multidens*, so that it is only the larger size of the latter which distinguished it. This may account for the lack of references to *D. foliaceus*, as most forms with a high thecal count at this horizon have been

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PLATE 4 All specimens from the Rorrington Member.

Fig. 1 *Dicellograptus divaricatus* (Hall), p. 29. Q.5269, Loc. 497. × 3.
Fig. 2 *Dicellograptus sextans* (Hall), p. 29. Q.5274, Loc. 497. × 3. See also Text-fig. 24, p. 30.
Fig. 3 *Dicellograptus intortus* Lapworth, p. 30. Q.5276, Loc. 390. × 3. See also Text-fig. 25, p. 28.
Fig. 4 *Nemagraptus gracilis* cf. *distans* Ruedemann, p. 31. Q.5264, Loc. 493. × 1.
Fig. 5 *Dicellograptus exilis* Elles & Wood, p. 31. Q.5280, Loc. 493. × 3.
Fig. 6 *Dicellograptus salopiensis* Elles & Wood, p. 31. Q.5279, Loc. 479. × 3. See also Text-fig. 26, p. 31.
Fig. 7 *Leptograptus validus* Elles & Wood, p. 28. Q.5267, Loc. 352. × 3.
Fig. 8 *Nemagraptus gracilis* (Hall), p. 28. Q.5263, Loc. 371. × 3.
Fig. 9 *Leptograptus validus* Elles & Wood, p. 28. GSM 99759, Spy Burn. × 3.


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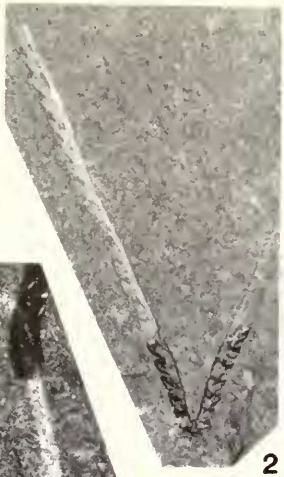
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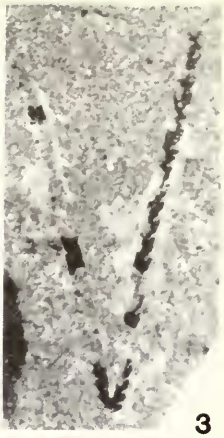
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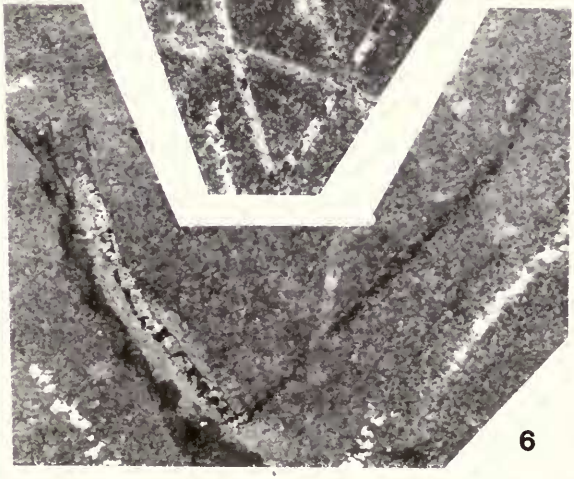
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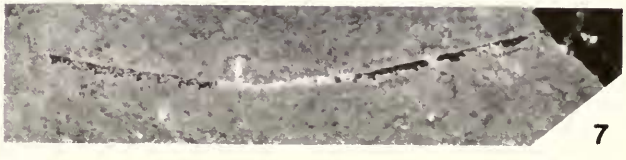
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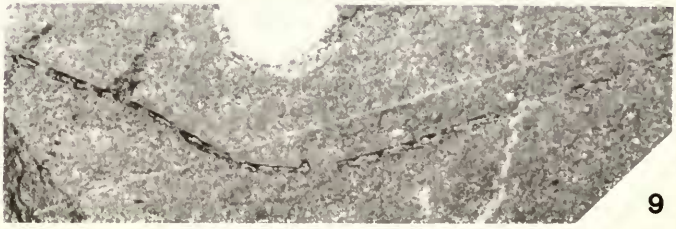
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called *multidens* (e.g. Bulman 1948). The type locality for *D. foliaceus* is in the Meadowtown Member. It does not seem to occur in the more shaly Rorrington Member but reappears in the Chirbury Formation and is found to the highest beds in the Shelve area.

MATERIAL AND HORIZONS. ?Betton Member: Q.5294, Loc. 575A. Meadowtown Member: Q.5293, Loc. 563. Whittery Member: Q.5295, Loc. 299; Q.5296, Loc. 294. Hagley Member: Q.5358, Loc. 739.

Diplograptus leptotheca Bulman 1946
Pl. 6, figs 1, 3, 4, 13

1946 *Diplograptus leptotheca* Bulman: 43; pl. 4, figs 1–15, pl. 6, fig. 11; text-figs 21–23.

DESCRIPTION. Rhabdosome up to 2 cm long, widening from 0·8–1·0 mm at th1[1] to 1·4–1·6 mm at 5 mm and reaching 1·8–2·0 mm distally. Thecae 18 to 14 per cm, proximal thecae with a well-marked excavation occupying a quarter of the width of the rhabdosome and a third to a half of the free ventral edge, distal thecae becoming orthograptid.

DISCUSSION. Some specimens which widened rather more rapidly were originally identified as *D. compactus* Elles & Wood, but none attain a width of more than 2·0 mm (*D. compactus* reaches 3·0 mm), and it seems preferable to call them all by the same name. This species was originally described from isolated material from Girvan and in dimensions is very similar to *D. diminutus* Ruedemann 1947 *non* Elles & Wood 1907. The American species has been figured from Kazakhstan by Tzaj (1976) and his figure is very like *D. leptotheca*.

MATERIAL AND HORIZONS. The species occurs fairly commonly in the Aldress Member; Q.5298, Q.5299, Loc. 302; Q.5297, Loc. 304; also in the succeeding parts of the Chirbury Formation, e.g. Hagley Member; Q.5300, Loc. 744. A single specimen, Q.5301, has been noted from the earlier Rorrington Member, Loc. 334, associated with *N. gracilis*.

Diplograptus multidens Elles & Wood 1907

1907 *Diplograptus* (*Mesograptus*) *multidens* Elles & Wood: 261; pl. 31, figs 9a–d, text-fig. 178.

DESCRIPTION. Rhabdosome 2·5 cm long, widening from 1·4 mm at the proximal end to 4·0 mm distally. Thecae 19 to 14 per cm, proximal ones amplexograptid but rapidly becoming orthograptid.

DISCUSSION. Only a single specimen (Q.5302) from the Aldress Member (Loc. 343) agrees with the dimensions of this species, whose type locality is at Pontesford, just to the north-east of the Shelve area. There are, however, a considerable number of smaller specimens with the same high thecal count which are now put with *D. foliaceus*. The contrast with the Oakwood Shales of Pontesford is striking, since there almost all the diplograptids show widths of more than 3 mm. The specimens from Shelve figured by Bulman (1948) as *D. multidens* I would regard as *D. foliaceus* on account of their width.

Genus *AMPLEXOGRAPTUS* Elles & Wood, 1907

TYPE SPECIES. *Diplograptus perexcavatus* Lapworth 1876.

Amplexograptus cf. *confertus* (Lapworth 1875)
Pl. 2, fig. 9

cf. 1875 *Climacograptus confertus* Lapworth: 655; pl. 34, figs 4a–f.
cf. 1907 *Diplograptus* (*Amplexograptus*) *confertus* (Lapworth); Elles & Wood: 269; pl. 31, figs 18a–c, text-figs 185a–c.

DESCRIPTION. Rhabdosome about 10 mm long, widening from about 0·8–1·0 mm at th1[1] to 1·6 mm. Thecae 16 per cm, with deep excavations occupying about a quarter of the width of the rhabdosome and half of the ventral margin.

DISCUSSION. This species is possibly represented by two specimens in the collection, one from the Hope Member (Q.5303, Loc. 959) and the other from the Stapeley Member (Q.5304, Loc. 946). Neither specimen is very well preserved. The species has been used as a zonal index in China for the lower part of the Llanvirn.

Amplexograptus fallax Bulman 1962
Fig. 31

1962 *Amplexograptus fallax* Bulman: 463; text-figs 2A–E.

DESCRIPTION. Rhabdosome up to 1·5 cm long, widening from 1·0 mm at th1[1] to 1·8 mm in the first 5 mm, then remaining uniform. Thecae 16 to 14 per cm, with deep and wide excavations occupying a quarter of the width of the rhabdosome and a third to a half of the free ventral edge; supragenicular wall distinctly inclined outwards. Th1[1] with a subapertural spine. Virgella short.

Fig. 31 *Amplexograptus fallax* Bulman. Q.5305, Loc. 346. × 10.

DISCUSSION. Two specimens from the Aldress Member match this species, but the preservation is not very good. Other specimens from higher horizons occasionally show thecae approaching the amplexograptid type but these can probably be accommodated in the various climacograptids which occur there and which show considerable range of thecal form depending on the preservation.

MATERIAL AND HORIZON. Aldress Member: Q.5305, Loc. 346; Q.5306, Loc. 318.

Genus *GLYPTOGRAPTUS* Lapworth 1873

TYPE SPECIES. *Diplograpsus tamariscus* Nicholson 1868.

Glyptograptus dentatus (Brongniart 1828)
Pl. 1, fig. 12; Pl. 2, fig. 10

1963 *Glyptograptus dentatus* (Brongniart); Bulman: 673; pl. 96, figs 1–5; text-figs 1, 4 (with full synonymy).

DESCRIPTION. Rhabdosome up to 2 cm long, widening from 0·5–0·8 mm at th1[1] to 1·8–2·0 mm in the first 10 mm, thereafter almost uniform. Thecae 8 to 9 in the first 5 mm, 6 to 7 in 5 mm distally, the first two thecae usually with short apertural spines. Virgella fairly stout.

DISCUSSION. A number of biserial forms occur in the Hope Member and some (e.g. Q.5308, Loc. 701) agree fairly well with the revised description of *G. dentatus* given by Bulman (1963). They are, however, not well preserved. A single specimen with similar characters occurs in the Mytton Member (Q.5307, Loc. 905) associated with horizontal didymograptids and seems reasonably distinct from the common diplograptid found at Shelve Church. Chen (1982) has described a number of new forms from China and Paškevičius (1981) has also described new glyptograptids. The early Shelve material is not abundant enough nor well enough preserved to allow comparisons.

Glyptograptus shelvensis Bulman 1963
Pl. 1, fig. 10

1963 *Glyptograptus shelvensis* Bulman: 676; pl. 97, figs 1–3, 14, text-figs 5a–f.

Bulman described this species as a small form of *G. dentatus*, and also described other specimens from the Mytton Member at Shelve Church under the names *G. austrodentatus anglicus* and *G. a. mutabilis*. Jenkins (1980) figured four specimens of these forms and claimed that they simply showed the effects of distortion on a single species. Apart from his text-figure caption being wrong (his sequence A to D should be reversed and his fig. 3C is *mutabilis* not *anglicus*), I do not think that he has fully considered the problem of compression of a three-dimensional object, and, although perhaps Bulman's forms are too restricted in range of variation, it is unwise to assume that only one form is present. Certainly there is no evidence that I have seen from Shelve Church specimens (e.g. BU.2076) to suggest that they should be put into the genus *Undulograptus* as Jenkins claims. There is considerable variation in thecal shape which is consistent with differing views of the rhabdosome. This is a common feature of the Shelve Inlier specimens, which are frequently preserved in some relief, and at Shelve Church in particular this apparent variation has been increased by tectonic deformation. The Whittard collection does not add enough to Bulman's original work for further comment at present.

Glyptograptus teretiusculus (Hisinger 1840)
Fig. 32; Pl. 5, fig. 10

1840 *Prionotus teretiusculus* Hisinger: 5; pl. 38, fig. 4.
1907 *Diplograptus* (*Glyptograptus*) *teretiusculus* (Hisinger); Elles & Wood: 250; pl. 31, figs 1a–e, text-figs 171a–d.

Description. Rhabdosome up to 2 cm long, widening from 1·0 mm at th1[1] to 1·6 mm in the first 10 mm, thereafter widening only a little. Thecae 14 to 12 per cm of simple glyptograptid type, the first two thecae bearing short spines. Virgella long, 3·5 mm, and slender. Median septum apparently complete.

Discussion. Only a few specimens (e.g. Q.5309, Loc. 375) can be safely attributed to this species, although some poorly preserved specimens may belong here. They occur in the Rorrington Member associated with *Nemagraptus*, *Leptograptus*, *Dicellograptus* and *Dicranograptus*, indicating the *N. gracilis* Zone. I originally identified a slender proximal end from the underlying Meadowtown Member as *G. teretiusculus*, but re-examination shows that the later thecae have distinct apertural lappets and I now regard it as more like *Orthograptus uplandicus*. However, Bulman (1936: text-fig. 22) figured *G. dentatus–teretiusculus* transients with fairly clear apertural lappets, but there does not seem to be good isolated material from higher horizons which shows the real shape of the thecae.

Fig. 32 *Glyptograptus teretiusculus* (Hisinger). Q.5309, Loc. 375. Drawing of Pl. 5, fig. 10, × 5.

Glyptograptus sp.
Fig. 33; Pl. 2, fig. 12

DESCRIPTION. Rhabdosome 16 mm long, widening from 0·6 mm at th1[1] to 2·5 mm. The thecae number 16 to 14 per cm and there is a short, stout virgella. The proximal end is very pointed and there is no trace of spines on the first pair of thecae.

DISCUSSION. This specimen from the Hope Member (Q.5310, Loc. 959) has distal thecae of the glyptograptid type, but the proximal end is quite unlike the contemporary *G. dentatus* and seems to be much more advanced. The first pair of thecae grow upwards like those of *Climacograptus brevis* with very little outward growth. The early occurrence of this feature merits notice but a single specimen is inadequate for the erection of a new species.

Fig. 33 *Glyptograptus* sp. Q.5310, Loc. 959. Proximal part of Pl. 2, fig. 12, × 5.

Genus ***ORTHOGRAPTUS*** Lapworth, 1873

TYPE SPECIES. *Graptolithus quadrimucronatus* Hall 1865.

The genus is kept here undivided as although *Rectograptus* Přibyl 1950 (type *D. truncatus* Lapworth) is reasonably well characterized the relationships of the other groups recognized by Elles & Wood are not clear.

Orthograptus cf. ***apiculatus*** (Elles & Wood 1907)
Pl. 5, fig. 14

cf. 1907 *Diplograptus* (*Orthograptus*) *rugosus* Emmons var. *apiculatus* Elles & Wood: 245; pl. 30, figs 7a–d, text-figs 166a–e.

cf. 1946 *Orthograptus apiculatus* (Elles & Wood); Bulman: 51; pl. 5, figs 1–16; pl. 6, figs 1–7; text-figs 24–29.

DESCRIPTION. The proximal end is 0·8–0·9 mm wide and there are 6 to 7 thecae in the first 5 mm. The rhabdosome widens gradually over the first 2 cm and long specimens may show a slight reduction in width distally. The thecal apertures have the characteristic spreading appearance of the *calcaratus* group with slight apertural lappets distinguishing them from the *truncatus* type.

DISCUSSION. This species was redescribed from well-preserved material by Bulman (1946). The Shelve specimens are generally narrower than the Scottish material and specimens in relief reach only 2 mm width at 3 cm length. However, the other characters appear to agree well with *O. apiculatus* and are quite distinct from *O. uplandicus* which occurs in the same beds.

MATERIAL AND HORIZONS. Spy Wood Member: Q.5312, Loc. 333; Q.5311, Loc. 422. Aldress Member: Q.5313, Loc. 395.

Orthograptus calcaratus vulgatus (Elles & Wood 1907)
Pl. 6, figs 14, 16

1907 *Diplograptus* (*Orthograptus*) *calcaratus* var. *vulgatus* Elles & Wood: 241; pl. 30, figs 5a–d; text-figs 160a–d.

Discussion. The highest beds in the Shelve Inlier yield numerous orthograptids of the *calcaratus* group. They show rapid widening from a proximal end of about 1·0 mm to a maximum of 2·8 or 3·0 mm, occasionally more, but they lack the stout proximal spines of the normal species. The proximal thecae number 7 in the first 5 mm, agreeing with some of the type material, although this figure is a good deal higher than the 10 to 8 per cm given by Elles & Wood. The intermediate value of 12 per cm is reported for the subspecies *acutus*, so it is probable that re-evaluation of all the forms is required. They may have some stratigraphical value if critically assessed, as *O. apiculatus* and *O. uplandicus* are also part of the complex.

Material and horizons. Hagley Member: Q.5315, Loc. 739. Whittery Member: Q.5314, Loc. 299.

Orthograptus truncatus (Lapworth 1877)
Pl. 6, figs 6, 15

1877 *Diplograptus truncatus* Lapworth: 133; pl. 6, fig. 17.
1907 *Diplograptus* (*Orthograptus*) *truncatus* Lapworth; Elles & Wood: 233; pl. 29, figs 3a–e; text-figs 154a, b.
1948 *Orthograptus truncatus* (Lapworth)?; Bulman: 226; text-fig. 3d.

A few specimens from the higher beds of the inlier show the characteristics of the *truncatus* group, simple straight thecae without paired apertural spines. Bulman (1948) has already figured a specimen from the Aldress Member as probably this species and Elles & Wood record it from Whittery Dingle, presumably in Whittery Member. Whittard's collection has produced only four specimens, two from the Aldress Member, Q.5316–7, Loc. 302, and two from the Whittery Member, Q.5318–9, Loc. 272. While not as wide as some *truncatus*, it must be remembered that these specimens are in at least partial relief where a maximum of 3 mm appears to be normal. The thecal count is higher than in Lapworth's Scottish specimens (8 or 9 in the first 5 mm as against 7) and this may reflect a real difference. However, the Shelve specimens agree better with the typical *truncatus* than with any of the varieties described by Elles & Wood and others.

Orthograptus uplandicus (Wiman 1895)
Fig. 34; Pl. 5, figs 6, 9, 12

1895 *Diplograptus uplandicus* Wiman: 274; pl. 9, fig. 1.
1963 *Orthograptus uplandicus* (Wiman); Geh: 248; pl. 4, fig. 7; text-fig. 10c.

Discussion. This species, described from Sweden, appears to be an early slender representative of the *calcaratus* group. The initial width is slightly less than in *calcaratus* (0·8 mm instead of

Fig. 34 *Orthograptus uplandicus* (Wiman). BU.2083, Beyrichia Bed, Rorrington. Enlargement of part of Pl. 5, fig. 9, × 5.

1 mm) and the maximum breadth is only 2·6 mm while *calcaratus* frequently reaches 3 mm or more. The thecae have distinct lateral lappets, particularly on the proximal thecae, which give the impression of slight introversion of the aperture. The virgella is well developed in some specimens, providing a link with *calcaratus*. The thecae number 6 to 7 in the first 5 mm but only 5 in 5 mm distally, generally higher numbers than in *calcaratus* and its varieties as figured by Elles & Wood.

A young specimen from Hubei, China was figured by Geh (1963), which is the only other record of the species I have traced since its original description.

Material and horizons. Rorrington Member: Q.5320, Loc. 956; Q.5322, Loc. 413. Spy Wood Member: Q.5321, Loc. 333; Q.5323, Loc. 369. Aldress Member: Q.5347, Loc. 304.

Genus *CLIMACOGRAPTUS* Hall, 1865

Type species. *Graptolithus bicornis* Hall 1847.

Climacograptus cf. *angustatus* Ekström 1937

Pl. 2, fig. 14

cf. 1937 *Climacograptus angustatus* Ekström: 36; pl. 7, figs 1–6.
cf. 1964 *Climacograptus angustatus* Ekström; Berry: 132; pl. 13, figs 10, 12, 13.

A single specimen from the Hope Member (Q.5324, Illing Colln.) has the width and thecal number of this species although it is considerably longer, reaching a length of 35 mm. The thecal excavations seem to be larger than shown in Ekström's plate but agree with Berry's more detailed account. The specimen is clearly distinct from the other diplograptids in the Hope Member and shows no trace of the zigzag septum characteristic of *Pseudoclimacograptus*.

Climacograptus aff. *antiquus lineatus* Elles & Wood 1906

Pl. 3, fig. 7; Pl. 6, figs 1, 19, 20

Description. The rhabdosome is generally 15–20 mm long and widens from 0·6 mm to 1·5 mm, rarely reaching 1·8 or 1·9 mm. It is thus generally narrower than *lineatus* which, in the type specimen, reaches 2·0 mm. Details of the proximal end are usually poor but there is a short, stout virgella and the first two thecae bear short spines which appear to be subapertural. The thecae number 6 or 7 in the first 5 mm but only 11 per cm distally. The excavations are fairly deep, occupying a quarter or a third of the width of the rhabdosome and about a quarter of the ventral wall. The distal thecae frequently show inclined excavations but the proximal ones have horizontal apertures and a sharp geniculum.

Discussion. These fairly numerous specimens of a comparatively slender climacograptid have the thecal characteristics of the *antiquus* type. Many are in relief and it is difficult to compare measurements, particularly width of rhabdosome and thecal excavations, with flattened type material. Pending a review of the relationships of Ordovician climacograptids, it seems unwise to propose further new names and these forms are here described under fairly open nomenclature.

The character of the proximal end clearly links them to *C. antiquus*, but they are much narrower and have generally more thecae. *C. macoris* Keller 1956 has the same width but the proximal end is quite different, as is that of *C. repetitus* Berry 1964. *C. yumenensis* Mu, Geh & Yin 1962 also lacks the paired thecal spines, although *C. shihuigouensis* var. *tricornis* Mu, Geh & Yin 1962 does have them. The latter, however, reaches a breadth of 2·3 mm although the normal form is only 1·5 mm wide. *C. antiquus lineatus* itself has been figured from China with a breadth of only 1·5 mm but the lower thecal count (8 to 11 per cm) (South Central Regional Atlas, see Wang *et al.* 1977). Hong (1957) had previously described *lineatus* from China with a breadth of at least 2 mm and 12 to 13 thecae per cm at the proximal end.

MATERIAL AND HORIZONS. The form is widely distributed in the Shelve area, ranging from the Meadowtown up to the Hagley Member. Meadowtown Member: Q.5325, Loc. 957A. Aldress Member: Q.5346, Loc. 302; Q.5326, Loc. 304. Hagley Member: Q.5327, Loc. 392A; Q.5328, Loc. 744.

Climacograptus brevis Elles & Wood 1906
Pl. 3, fig. 5; Pl. 5, figs 7, 8

1906 *Climacograptus brevis* Elles & Wood: 192; pl. 27, figs 2a–f; text-figs 125a, b.

This small species of *Climacograptus* occurs in some numbers at a few localities in the Rorrington (e.g. Q.5330, Loc. 519) and Aldress Members (e.g. Q.5353, Loc. 355; Q.5348, Loc. 343A), the latter, however, being very poorly preserved. The specimens range up to nearly 2 cm in length but with a maximum width of only 0·9 mm, and thecae generally 12 to 14 per cm, agreeing with the original description. Elles & Wood did not record the species from the Shelve area but its associates in the Rorrington Member match those at the type locality. A single specimen, Q.5331, from the Spy Wood Member, Loc. 369, may also belong here, as although it has a maximum width of only 0·6 mm it is in full relief in a fine sandstone.

A further specimen, Q.5329, from the Meadowtown Member, Loc. 314, is rather broader at 1·3 mm, and also appears to belong here, although as it has a very stout virgella it may be a different form.

Climacograptus peltifer Lapworth 1876
Pl. 6, fig. 17

1876 *Climacograptus bicornis* var. *peltifer* Lapworth: pl. 2, fig. 53.
1906 *Climacograptus bicornis* var. *peltifer* Lapworth; Elles & Wood: 196; pl. 26, figs 10a–c.

DESCRIPTION. Rhabdosome 10 mm long, widening from 0·8 mm to 1·1 mm. Thecae 14 per cm with excavations occupying a third of the width of the rhabdosome and a quarter to a third of the free ventral wall. Proximal end with short stout virgella and long curved spines from the first two thecae, the spines then covered by a thin film extending up to the apertures of the second pair of thecae.

PLATE 5 Figs 1–7, 10 from Rorrington Member; Figs 8, 9, 11–14 from Spy Wood Member.

Fig. 1 *Dicranograptus rectus* Hopkinson, p. 32. Q.5289, Loc. 956. × 3. See also Text-fig. 28, p. 32.
Fig. 2 *Dicranograptus brevicaulis* Elles & Wood, p. 32. Q.5283, Loc. 374. × 3.
Fig. 3 *Dicranograptus rectus* Hopkinson, p. 33. Q.5290, Loc. 373. × 2.
Fig. 4 *Leptograptus latus* Elles & Wood, p. 29. **Lectotype** herein selected, GSM 49763, Spy Burn. × 2.
Fig. 5 *Pseudoclimacograptus modestus* (Ruedemann), p. 45. Q.5336, Loc. 334. × 3.
Fig. 6 *Orthograptus uplandicus* (Wiman), p. 40. Q.5320, Loc. 956. × 3.
Figs 7, 8 *Climacograptus brevis* Elles & Wood, above. Fig. 7, Q.5330, Loc. 519. Fig. 8, Q.5331, Loc. 369. Both × 3. See also Pl. 3.
Fig. 9 *Orthograptus uplandicus* (Wiman), p. 40. BU.2083 (Lapworth Collection), Beyrichia Bed, Rorrington. × 3. See also Text-fig. 34, p. 40.
Fig. 10 *Glyptograptus teretiusculus* (Hisinger), p. 38. Q.5309, Loc. 375. × 3. See also Text-fig. 32, p. 38.
Fig. 11 *Dicranograptus rectus* Hopkinson, p. 33. Q.5291, Loc. 417A. × 3.
Fig. 12 *Orthograptus uplandicus* (Wiman), p. 40. Q.5321, Loc. 333. × 3.
Fig. 13 *Dicellograptus exilis* Elles & Wood, p. 31. Q.5281, exact locality unknown. × 3.
Fig. 14 *Orthograptus* cf. *apiculatus* Elles & Wood, p. 39. Q.5311, Loc. 422. × 2.


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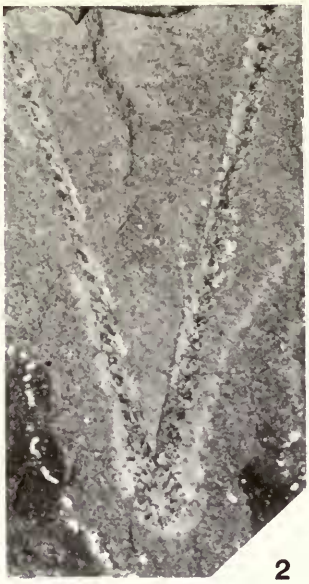
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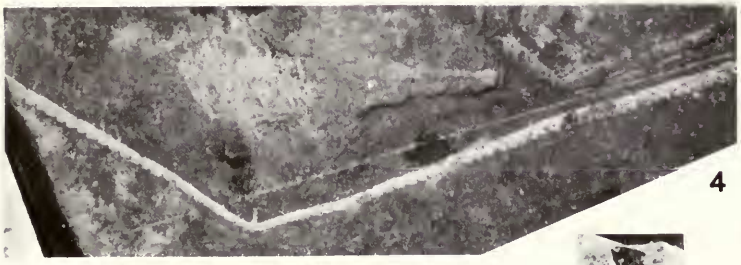
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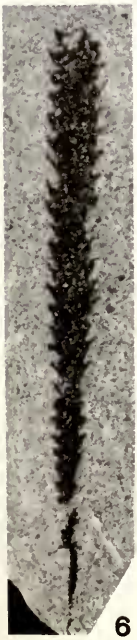
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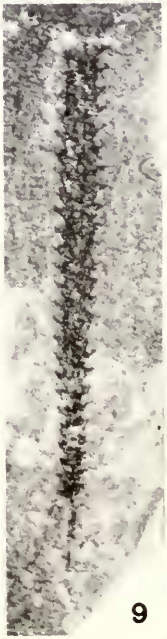
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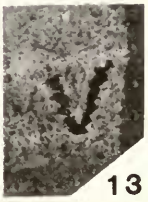
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Discussion. On the basis of identifications by Miss Elles, Whittard (1931) concluded that the fauna from Hagley Quarry indicated a level about the *clingani–linearis* Zones junction. Miss Elles listed this specimen (GSM RR2820) as *C. supernus* Elles & Wood, which would indicate an even higher level in the Ordovician. However, the specimen agrees well with the type of *C. peltifer* which is characteristic of a much lower horizon and the shelly fauna from the upper part of the Shelve succession fits more easily with the reassigned age when compared with other areas.

Climacograptus cf. ***tubularis*** Elles & Wood 1906
Pl. 6, fig. 2

cf. 1906 *Climacograptus Wilsoni* var. *tubularis* Elles & Wood: 199; pl. 26, fig. 13; text-fig. 129.

Rhabdosome 16 mm long, widening gradually from 0·9 mm to 1·3 mm, thecae 12 to 10 per cm, with excavations occupying one fifth of the width of the rhabdosome and a third of the free ventral wall. There is a stout virgella and the first pair of thecae have mesial spines. There is a straight median septum. The single specimen is in full relief, but much of the periderm has been lost owing to the coarse nature of the sediment. The general characters are those of *C. wilsoni* but there is no proximal sac developed. It is narrower than the specimens of *C. antiquus lineatus* and also has fewer thecae than that species as found in the Shelve area. The specimen, Q.5332, was found in the Aldress Member, Loc. 304.

Climacograptus sp.
Fig. 35; Pl. 6, fig. 9

A single specimen, Q.5333, from the Aldress Member, Loc. 344, has a well-developed proximal spine and was at first considered to be *C. spiniferus* Ruedemann. Close examination, however, shows that the spine is either a very stout sicular apertural spine (not usually seen in this type of *Climacograptus*) or a genicular spine from th1^2. The rock is broken away from much of the proximal end but there seems to be little trace of a corresponding spine on th1^1. However, a stout virgella may have been present. The rhabdosome is about 4 mm long and reaches a width of 1·1 mm. There are 5 thecae in 3·5 mm. In general size the specimen approaches *C. pygmaeus* Ruedemann (1925) but is clearly not a *typicalis* type as the sicula is not exposed below th1^2. *C. prolificus* Parks (1928) is also described as having two 'apertural spines' but Riva (1974) regards it as a synonym of *C. pygmaeus*. *C. praesupernus* Obut & Sobolevskaya 1964 has three spines at the proximal end, the lateral ones being about 1 mm long. This is rather stouter than the single spine preserved on this specimen but the other dimensions match fairly well. Tzaj's further account (1976) of this Russian species does not add any more detail or clear figures to help in identification. As only the single example is so far known from Shelve, it is best left without formal identification.

Fig. 35 *Climacograptus* sp. Q.5333, Loc. 344. Enlargement of Pl. 6, fig. 9, × 10.

Genus *PSEUDOCLIMACOGRAPTUS* Přibyl, 1947

TYPE SPECIES. *Climacograptus Scharenbergi* Lapworth 1876.

Pseudoclimacograptus scharenbergi (Lapworth 1876)
Pl. 6, figs 12, 18

1876 *Climacograptus Scharenbergi* Lapworth: pl. 2, fig. 55.
1906 *Climacograptus Scharenbergi* Lapworth; Elles & Wood: 206; pl. 27, figs 14a–e; text-figs 139a–c.

DISCUSSION. This species is fairly common in the Hagley and Whittery Members but does not seem to occur lower. The preservation, although often in relief, is not generally good as the specimens are distorted. Distinction from *P. modestus* is mainly on thecal count (*modestus* with 9 thecae in first 5 mm, *scharenbergi* with 7) and as noted by Bulman (1948) the proximal end in *scharenbergi* tapers rather more than in *modestus*. The development of the virgella and proximal thecal spines is very variable. A few specimens appear to show supragenicular walls slightly inclined inwards as in *C. s. angulatus* Bulman, but they lack the steeply inclined apertures of that form.

MATERIAL AND HORIZONS. Hagley Member: Q.5334, Loc. 399; Q.5335, Loc. 392A. Whittery Member: Q.5345, Loc. 272.

Pseudoclimacograptus modestus (Ruedemann 1908)
Pl. 5, fig. 5

1908 *Climacograptus modestus* Ruedemann: 432; pl. 28, fig. 30; text-figs 400–403.

This species is not very common in the collection but has been found in the Rorrington Member, Q.5336, Loc. 334, and similar forms with a high thecal count occur in the Whittery Member, Q.5359, Loc. 272. There seems to be some distortion in many of the specimens. A critical revision of the species is required since Ruedemann's (1908) account is quite inadequate and Riva (1974) did not figure or discuss the type material. The type of *C. parvus* Hall (figured by Riva, 1974) appears to be closer to *modestus* than to *scharenbergi*, assuming that Riva is correct in assigning it to *Pseudoclimacograptus*.

Family **LASIOGRAPTIDAE** Lapworth, 1879

Genus *LASIOGRAPTUS* Lapworth, 1873

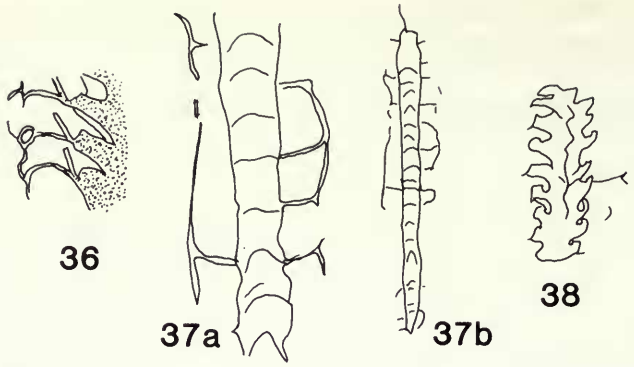
TYPE SPECIES. *Lasiograptus costatus* Lapworth 1873.

Lasiograptus costatus Lapworth 1873
Figs 36–38; Pl. 6, figs 5, 8

1873 *Lasiograptus costatus* Lapworth: 559.
1908 *Lasiograptus* (*Thysanograptus*) *Harknessi* var. *costatus* (Lapworth); Elles & Wood: 327; pl. 34, figs 2a–d; text-figs 215a–g.

DESCRIPTION. Rhabdosome small, rarely more than 1 cm long, widening from 1·2 mm to 2·0 mm, exclusive of lacinia. Thecae 16 per cm, of characteristic lasiograptid type, excavations sloping inwards and occupying about a third of the width of the rhabdosome, supragenicular wall inclined at about 45°, genicular spines stout, slightly curved, up to 1 mm long, occasionally seen to form a lacinia.

DISCUSSION. The above description is based on the Shelve specimens, some of which are well preserved in partial relief. They do not show the well-developed ventral lacinia seen in many of the original Scottish specimens, including the type, but this is probably the result of different preservation. In the black shales the specimens are reduced to a virtually flat silvery film and the three-dimensional nature of the lacinia is not so clear. The type specimen, however, shows that the single apertural process divides laterally almost at once and each branch grows out for



Figs 36–38 *Lasiograptus costatus* Lapworth. Fig. 36, BU.1341, Hartfell Shales, Dobb's Linn. Part of lectotype (sel. Elles & Wood 1908: pl. 34, fig. 2b) showing lateral bifurcation of apertural spine and subsequent development of the lacinia, ×7. Fig. 37a, b, on same slab as Sedgwick Museum, Cambridge, SM A23399, scalariform view. a, ×7; b, ×2½. Fig. 38, Q.5337, Loc. 343A. Drawing of Pl. 6, fig. 8, ×5.

about 1 mm before dividing again in the vertical direction, the divisions then joining up with those from the thecae above and below to form vertical rods which in a few cases show traces of lateral connections. This structure was described by Elles & Wood (1908), but its full three-dimensional nature does not seem to have been realised. Their figure of a 'scalariform view' (Elles & Wood 1908: text-fig. 215e) is in fact only subscalariform and like most views shows effectively only a single strand on each side. On the same slab as another of their figured specimens is a fine true scalariform view (Fig. 37) showing also a single vertical lacinial thread on each side. The specimen is in a blocky mudstone and excavation, if possible, might reveal the other parts of the lacinia. What it suggests is that the cross section of the total rhabdosome is approximately square with the vertical strands at the corners, although the thecal part is more or less rectangular with its width being about twice the thickness.

The species has been described from Kazakhstan by Tzaj (1976), but his specimens have much longer thecal spines with no trace of vertical lacinia and they are probably a different form. Geh (1963) has also figured specimens from China as this species, but his text-figure shows the characters of *L. spinatus* Hadding which has a more tapering rhabdosome. *Paraclimacograptus weberi* Keller 1956, although incomplete, looks very close to some of the Shelve specimens.

MATERIAL AND HORIZON. The species occurs in a few localities of the Aldress Member, including the *Dictyonema* horizon: Q.5337, Loc. 343A; Q.5349, Loc. 344; Q.5350, Loc. 346.

Genus *GYMNOGRAPTUS* Bulman 1953

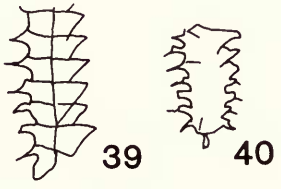
TYPE SPECIES. *Diplograptus linnarssoni* Moberg 1896.

There seems to be some difficulty in the identification of this genus in spite of the detailed studies of isolated material (Urbanek 1959, Jaanusson 1960). The earliest illustrations of the type species *Diplograptus linnarssoni* by Moberg (1896) show thecae which are denticulate at most, and the first full description by Hadding (1913) mentions thecal 'denticles', the figures showing no trace of spines. Bulman's (1953) account giving the first description of the genus says 'thecae . . . provided with long apertural spines.' Certainly the topotypic material in the Lapworth Collection in Birmingham (labelled '*Gymnograptus Linnarssoni* Tullb. mscr. Fågelsång. 1878. S. A. Tullberg.') shows long spines on the thecae in flattened material but a speci-

men in relief does not show any spines, agreeing with Hadding's illustration of a relief specimen. Wang (1978) has proposed a second species, *G. spinatus*, on the assumption that *G. linnarssoni* does not have spines. Both forms have a zigzag median suture although it is not so well seen in *G. spinatus*. This suggests that the two forms may simply represent preservational differences. Lee (1963) noted thecal spines on his material and his illustrations show some thecae approaching the lasiograptid condition, particularly proximally. Urbanek (1959) pointed out that his fragmentary *Gymnograptus* sp. was very similar to the type of *Lasiograptus retusus* Lapworth which has a somewhat zigzag median septum. *L. retusus*, however, has its own problems as it is based on a single specimen showing no spines. The spined forms attributed to it by Elles & Wood (1908: pl. 34, figs 3b, c) are not conspecific with the holotype (1908: pl. 34, fig. 3a), as has been recognized by later workers. Lee (1963) made *L. retusus* the type of his new genus *Prolasiograptus*, but his Chinese specimen is much wider than the type of *retusus* and his new species *P. asiaticus* is nearer. Both forms, however, show the small first theca which is a feature of *Gymnograptus* (Lee 1963: text-figs 6 and 7c). The proximal end in the type specimen of *retusus* is not clear enough to show whether or not it has this feature.

Gymnograptus (?) sp.
Figs 39, 40; Pl. 3, figs 10, 15, 16

Description. Rhabdosome up to 3 cm long, widening from about 1·0–1·2 mm at the proximal end to 2·0 mm in the first 10 mm and slowly afterwards to a maximum of 3·0 mm. Thecae 8 to 10 in the first 5 mm but only 7 in 5 mm distally, of gymnograptid type with a short supragenicular wall inclined inwards in the distal thecae and bearing stout genicular spines up to 1 mm long. Proximal end not well preserved but more or less rounded and with prominent virgella.



Figs 39, 40 *Gymnograptus* (?) sp. Fig. 39, Q.5338, Loc. 234. Enlargement of part of Pl. 3, fig. 10. Fig. 40, BU.2082, Betton Dingle. Proximal end of Pl. 3, fig. 16. Both × 5.

Discussion. This form is fairly common in the Betton Member but is poorly preserved. It agrees fairly well with one of the specimens figured by Elles & Wood as *Lasiograptus retusus*, but not with the holotype of that species which shows a fairly strong zigzag septum and no trace of thecal spines. The shape of the thecae is strongly reminiscent of *Gymnograptus linnarssoni*, but the proximal end is rounded and there is a stout virgella. Some of the specimens show distinct grooves at right angles to the median septal line which are similar to those figured by Berry (1964) in his Norwegian *Amplexograptus munimentus* and *A. tubulus*. Both species are from the same horizon as the Shelve specimens, but Berry makes no mention of thecal spines and his forms have slightly fewer thecae per cm. However, in view of the difficulty noted earlier in seeing spines in some preservations of *Gymnograptus*, it is possible that the Norwegian species are actually gymnograptids.

Since the Shelve specimens are not well preserved, it has been felt better to leave them under an open nomenclature until the other problems are cleared up. The association with pendent didymograptids in the Betton Member is earlier than the standard range of *Gymnograptus* in Scandinavia and China where it always occurs immediately post-*murchisoni* Zone.

Material and horizon. Betton Member: Q.5338, Loc. 234; Q.5339–40, Loc. 388; Q.5341–2, Loc. 232.

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Appendix: Locality list

Most of the localities have been traced on Whittard's field maps although some are still doubtful. The species listed include some that have not been checked by critical re-examination of specimens but are added to indicate the range of species present at each locality.

54. 975 m at 358° from Hope Hall, Hope. SJ 3482 0290. Hope Member. *Didymograptus pluto*; *Acrograptus acutidens*; *A. gracilis*; ? *Glyptograptus dentatus.*
58. Stream section 716 m at 126° from Bench Mark 122 m by road at Leigh Hall. SJ 3399 0312. Hope Member. *Acrograptus gracilis.*
132. 881 m at 91° from Methodist Chapel, Meadowtown. SJ 3201 0120. Stapeley Shale Member. *Glossograptus* cf. *acanthus*; *Acrograptus* cf. *acutidens.*
133. same as 132. *Didymograptus pluto*; *D.* cf. *stabilis*; *Glossograptus fimbriatus*; ? *Triarthrus* sp.
140. 1868 m at 293° from Stiperstones Inn. SJ 3464 0116. Hope Member. *Didymograptus* cf. *stabilis.*
144. Section with centre 533 m at 242° from Methodist Chapel, Meadowtown. SJ 3065 0097. Meadowtown Member. *Dicellograptus* cf. *sextans*; *Dicranograptus irregularis.*
164. 158 m at 260° from Methodist Chapel, Meadowtown. SJ 3096 0120. Meadowtown Member. *Dicellograptus divaricatus*; *D.* cf. *sextans*; cf. *Cryptograptus* sp.; cf. *Dictyonema* sp.
169. Stream section 646 m at 25° from NE corner of Hogstow Hall, west of Crowsnest. SJ 3677 0178. Hope Member. *Didymograptus pluto*; *Expansograptus* cf. *euodus.*
204. Section centred on 1268 m at 316° from Hope Church. SJ 3322 0242. Hope Member. *Didymograptus pluto*; ? hyolithid.
222A. 600 m W of Leigh Manor, on edge of Overton's Wood. SJ 3311 0229. Hope Member. *Didymograptus pluto.*
232. 661 m at 50° from Methodist Chapel, Meadowtown. SJ 3164 0164. Betton Member. *Didymograptus murchisoni*; ? *Gymnograptus* sp.
234. In Betton Dingle, 230 m NW of Lyde Cottage. SJ 3165 0169. Betton Member. *Didymograptus murchisoni*; *Gymnograptus*? sp.
272. Stream section 250 m south of Chirbury. SO 2620 9810. Whittery Member. *Orthograptus truncatus*; *Pseudoclimacograptus scharenbergi*; *P.* cf. *modestus.*
279. 300 m ENE of The Bog. SO 3595 9789. Mytton Member. ? *Tetragraptus* sp.
294. Spring Coppice, 866 m at 167° from Bench Mark 359·5 (ft) beside Woodmore, near Wotherton. Whittery Member. SO 2783 9960. *Diplograptus foliaceus*; *Dictyonema* sp.
299. Old quarry in Whittery Wood, 1768 m at 290° from Methodist Chapel, Priestweston. SO 2747 9808. Whittery Member. *Diplograptus foliaceus*; *Amplexograptus* cf. *fallax*; *Orthograptus calcaratus vulgatus.*
302. Stream section 800 m east of Wotherton, at point 1963 m at 174° from St Mark's Church, Marton. SJ 2905 0066. Aldress Member. *Diplograptus leptotheca*; *Orthograptus truncatus*; *Climacograptus* cf. *antiquus*; *Dictyonema fluitans.*
304. West of same stream, 1628 m at 174° from St Mark's Church, Marton. SJ 2902 0068. Aldress Member. *Diplograptus leptotheca*; *Orthograptus* cf. *uplandicus*; *Climacograptus* aff. *antiquus lineatus*; *C.* cf. *tubularis.*
307. 302 m WSW of Little Weston. SO 2903 9832. Betton Member. *Didymograptus* cf. *stabilis*; *D.* cf. *murchisoni.*
314. Laneside exposure 360 m W of Little Weston. SO 2894 9856. Meadowtown Member. *Dicranograptus* sp.; *Climacograptus* cf. *brevis.*
318. In Ox Wood, 450 m NW of Rorrington Lodge. SJ 2905 0082. Aldress Member. *Amplexograptus fallax.*
324. Old quarry 400 m NW of Little Weston. SO 2910 9878. Meadowtown Member. *Dicellograptus sextans*; *Dicranograptus irregularis*; *Climacograptus* sp.
329. Road section 1950 m at 10° from Methodist Chapel, Priestweston. SO 2950 9935. Meadowtown Member. *Cryptograptus schaeferi*; *Glyptograptus* sp.
333. Trackside exposure 500 m SW of Rorrington. SJ 2965 0027. Spy Wood Member. *Orthograptus* cf. *apiculatus*; *O. uplandicus.*

334. Grey Grass Dingle, 2164 m at 306° from Stapeley Farmhouse. SJ 2977 0017. Rorrington Member. *Nemagraptus gracilis*; *Leptograptus* cf. *validus*; *Dicranograptus brevicaulis*; *Diplograptus leptotheca*; *Pseudoclimacograptus modestus*.

343A. 1689 m at 337° from Methodist Chapel, Old Church Stoke. SO 2830 9640. Aldress Member. *Cryptograptus tricornis*; *Diplograptus multidens*; *Orthograptus* cf. *apiculatus*; *Climacograptus* cf. *brevis*; *Lasiograptus costatus*.

344. Aldress Dingle, 1454 m at 330° from Methodist Chapel, Old Church Stoke. SO 2788 9601. Aldress Member. *Diplograptus* cf. *leptotheca*; *Orthograptus* sp.; *Climacograptus* sp.; *Lasiograptus* cf. *costatus*; *Dictyonema fluitans*.

346. 2252 m at 348° from Methodist Chapel, Old Church Stoke. SO 2821 9705. Aldress Member. *Cryptograptus* sp.; *Diplograptus* sp; *Amplexograptus fallax*; *Lasiograptus* cf. *costatus*.

352. 2243 m at 353° from Methodist Chapel, Old Church Stoke. SO 2841 9707. Rorrington Member. *Nemagraptus* sp.; *Leptograptus validus*; ? *Dictyonema* sp.

355. 1923 m at 342° from Methodist Chapel, Old Church Stoke. SO 2811 9684. Aldress Member. *Cryptograptus tricornis*; *Corynoides* cf. *curtus*; *Diplograptus* cf. *leptotheca*; *Orthograptus* sp.; *Climacograptus* cf. *brevis*.

369. 1091 m at 333° from Methodist Chapel, Old Church Stoke. SO 2816 9582. Spy Wood Member. *Orthograptus* cf. *uplandicus*; *Climacograptus brevis*.

371. River bank in Spy Wood, 90 m NE of Spy Wood Cottage. SO 2820 9579. Rorrington Member. *Nemagraptus gracilis*; *Leptograptus validus*; *Dicranograptus brevicaulis*.

373. 1070 m at 334° from Methodist Chapel, Old Church Stoke. SO 2821 9580. Rorrington Member. *Leptograptus validus*; *Dicranograptus rectus*; *Amplexograptus* sp.; *Orthograptus* sp.; *Pseudoclimacograptus modestus*; *Dictyonema* sp.

374. 1082 m at 335° from Methodist Chapel, Old Church Stoke. SO 2823 9583. Rorrington Member. *Leptograptus validus*; *Dicellograptus* cf. *intortus*; *Dicranograptus brevicaulis*; *Pseudoclimacograptus* cf. *modestus*.

375. Aldress Dingle, 1079 m at 336° from Methodist Chapel, Old Church Stoke. SO 2823 9584. Rorrington Member. *Leptograptus* cf. *validus*; *Dicellograptus* sp.; *Glyptograptus teretiusculus*; *Pseudoclimacograptus* cf. *modestus*.

PLATE 6 Figs 1–9 from the Aldress Member; Figs 10, 11, 14, 15 from the Whittery Member and Figs 12, 13, 16–20 from the Hagley Member.

Fig. 1 *Climacograptus* aff. *antiquus lineatus* Elles & Wood, p. 41 (long specimen on right). Q.5326. Also *Diplograptus leptotheca* Bulman, p. 36. Q.5297, Loc. 304. × 3.

Fig. 2 *Climacograptus* cf. *tubularis* Elles & Wood, p. 44. Q.5332, Loc. 304. × 3.

Figs 3, 4 *Diplograptus leptotheca* Bulman, p. 36. Fig. 3, Q.5298; Fig. 4, Q.5299a; both Loc. 302. Both × 3.

Fig. 5 *Lasiograptus costatus* Lapworth, p. 45. BU.2084, Lower Point, Aldress Burn. × 3.

Fig. 6 *Orthograptus truncatus* Lapworth, p. 40. Q.5316, Loc. 302. × 3.

Fig. 7 *Cryptograptus tricornis* (Carruthers), p. 25. Q.5257, Loc. 343A. × 3.

Fig. 8 *Lasiograptus costatus* Lapworth, p. 45. Q.5337, Loc. 343A. × 3. See also Text-fig. 38, p. 46.

Fig. 9 *Climacograptus* sp., p. 44. Q.5333, Loc. 344. × 6. See also Text-fig. 35, p. 44.

Figs 10, 11 *Diplograptus foliaceus* (Murchison), p. 34. Fig. 10, Q.5295, Loc. 747. Fig. 11, Q.5296, Loc. 294. Both × 3. See also Pl. 3.

Fig. 12 *Pseudoclimacograptus scharenbergi* (Lapworth), p. 45. Q.5334, Loc. 399. × 3.

Fig. 13 *Diplograptus leptotheca* Bulman, p. 36. Q.5300, Loc. 744. × 3.

Fig. 14 *Orthograptus calcaratus vulgatus* Elles & Wood, p. 40. Q.5314, Loc. 299. × 3.

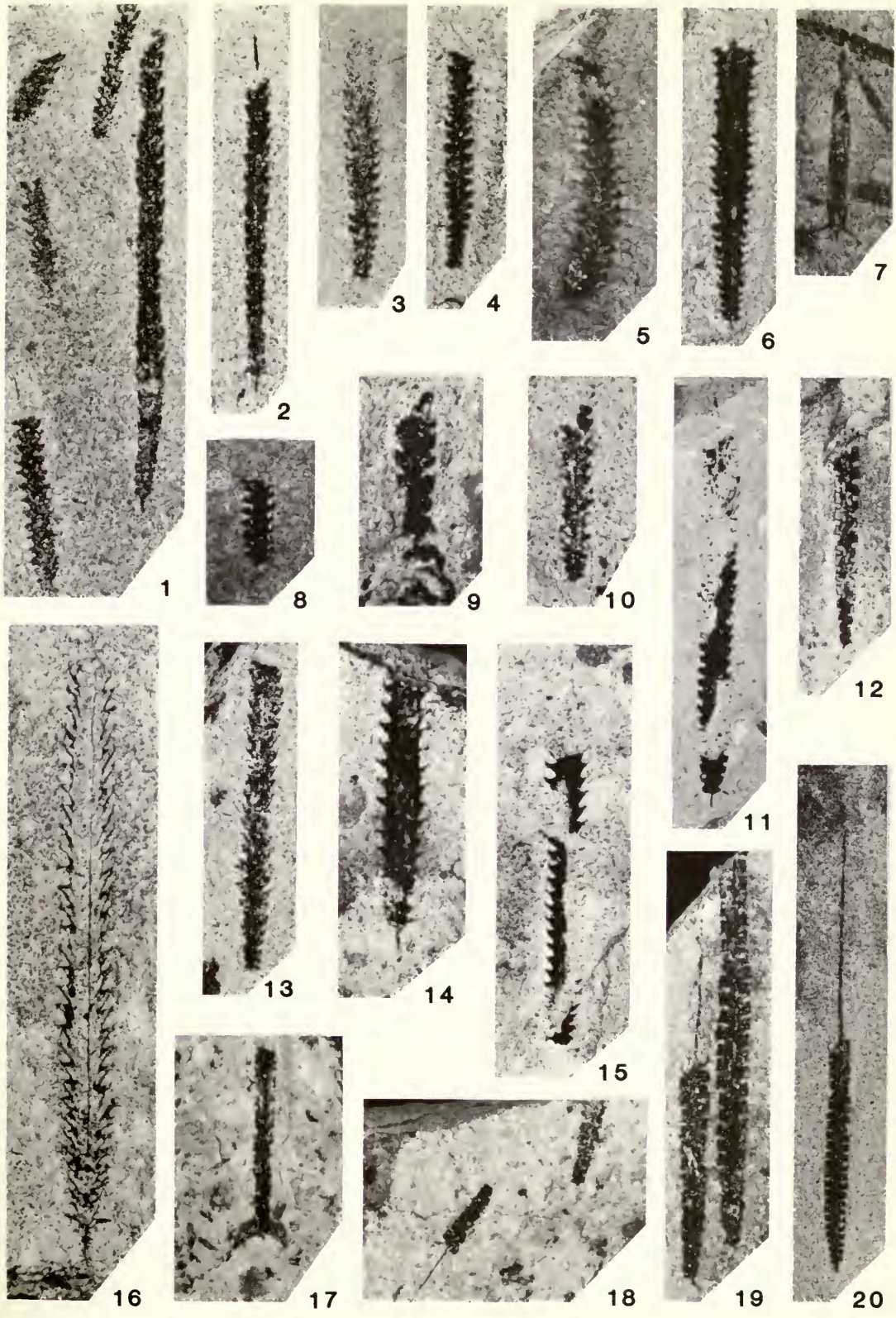
Fig. 15 *Orthograptus truncatus* Lapworth, p. 40. Q.5318, Loc. 272. × 3.

Fig. 16 *Orthograptus calcaratus vulgatus* Elles & Wood, p. 40. Q.5315, Loc. 739. × 3.

Fig. 17 *Climacograptus peltifer* Lapworth, p. 42. GSM RR2820, Hagley Quarry. × 3.

Fig. 18 *Pseudoclimacograptus scharenbergi* (Lapworth), p. 45. Q.5335, Loc. 392A. × 3.

Figs 19, 20 *Climacograptus* aff. *antiquus lineatus* Elles & Wood, p. 41. Fig. 19, Q.5327, Loc. 392A. × 3. Fig. 20, Q.5328, Loc. 744. × 2. See also Pl. 3.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377. 1170 m at 342° from Methodist Chapel, Old Church Stoke. SO 2830 9596. Rorrington Member. *Dicellograptus sextans*; *Nemagraptus gracilis*; *Ptilograptus* sp.
382A. 1347 m at 357° from Methodist Chapel, Old Church Stoke. SO 2858 9618. Betton Member. *Didymograptus murchisoni.*
388. 1146 m at 349° from Methodist Chapel, Old Church Stoke. SO 2847 9596. Betton Member. *Didymograptus murchisoni*; *Gymnograptus*? sp.
389. 1161 m at 347° from Methodist Chapel, Old Church Stoke. SO 2841 9596. Rorrington Member. *Dicellograptus intortus.*
390. 1170 m at 345° from Methodist Chapel, Old Church Stoke. SO 2836 9597. Rorrington Member. *Nemagraptus gracilis*; *Dicellograptus* cf. *divaricatus*; *D. intortus*; *Climacograptus brevis*; *Pseudoclimacograptus* sp.; ? *Acanthograptus* sp.
392A. River bank in Spy Wood, 160 m N of Rock House. SJ 2762 9578. Hagley Member. *Climacograptus* aff. *antiquus lineatus*; *Pseudoclimacograptus scharenbergi.*
394. Brynkin Dingle, 100 m NW of Bryncyn Green. SO 2805 9555. Spy Wood Member. *Dicellograptus intortus*; *Climacograptus* cf. *brevis*; *Orthograptus* cf. *uplandicus.*
395. Brynkin Dingle, 190 m NW of Bryncyn Green. SO 2801 9563. Aldress Member. *Orthograptus* cf. *apiculatus*; *Cryptograptus tricornis*; *Dictyonema fluitans.*
399. Old quarry 200 m N of Church Stoke Hall, SJ 2746 9419. Hagley Member. *Pseudoclimacograptus scharenbergi.*
413. Lane 91 m SW of Rorrington Hall. SJ 2982 0065. Spy Wood Member. *Orthograptus* cf. *uplandicus.*
417A. Track 90 m due E of Rorrington Hall. SJ 2995 0074. Spy Wood Member. *Dicellograptus* sp.; *Dicranograptus rectus*; *Orthograptus* sp.
422. 365 m SW of Lower Wood Farm. SJ 3062 0232. Spy Wood Member. *Orthograptus* cf. *apiculatus*; *O.* cf. *uplandicus.*
437. Section along Holywell Brook, 440 m SE of Rorrington. SJ 3036 0027. Betton Member. *Didymograptus murchisoni.*
444. 1231 m at 301° from Stapeley Farmhouse, near Whitegrit. SO 3044 9950. Weston Member. *Didymograptus murchisoni.*
463. Long section extending from point 1268 m at 334° to another point 1256 m at 349°, both measured from Stapeley Farmhouse. SJ 3097 0000 to 3128 0009. Stapeley Member. *Didymograptus* aff. *miserabilis.*
479. Stream section 400 m S of Desert. SJ 3059 0148. Rorrington Member. *Dicellograptus* cf. *sextans*; *D. salopiensis*; *Dicranograptus brevicaulis.*
493. Stream section 90 m N of Desert. SJ 3066 0198. Rorrington Member. *Nemagraptus gracilis* cf. *distans*; *Dicellograptus exilis.*
497. Lower Wood Farm. SJ 3085 0260. Rorrington Member. ? *Nemagraptus* sp.; *Dicellograptus sextans*; *D. divaricatus.*
503. 573 m at 220° from Methodist Chapel, Meadowtown. SJ 3074 0080. Meadowtown. Member. *Cryptograptus schaeferi*; *Dicellograptus* cf. *vagus*; *Dicranograptus* cf. *irregularis.*
519. 546 m at 324° from Methodist Chapel, Meadowtown. SJ 3080 0168. Rorrington Member. cf. *Nemagraptus* sp.; cf. *Leptograptus* sp.; *Climacograptus brevis.*
536. 1247 m at 31° from Methodist Chapel, Meadowtown. SJ 3180 0225. Betton Member. *Didymograptus murchisoni*; *D.* aff. *miserabilis*; ?*Gymnograptus* sp.; lingulid.
563. 168 m at 33° from Methodist Chapel, Meadowtown. SJ 3120 0138. Meadowtown Member. *Diplograptus* cf. *foliaceus.*
575A. 300 m at 177° from Methodist Chapel, Meadowtown. SJ 3116 0092. Betton Member. *Diplograptus* cf. *foliaceus.*
594. Grey Grass Dingle, 500 m due S of Rorrington Hall. SJ 2988 0028. Rorrington Member. *Nemagraptus gracilis*; *Leptograptus* sp.
635. Farmyard at Brithdir Farm. SO 3010 9528. Hope Member. *Pseudophyllograptus* cf. *angustifolius*; *Didymograptus pluto*; *D.* cf. *stabilis.*
701. East side of Ritton Castle. SO 3452 9772. Hope Member. *Acrograptus acutidens*; *Glyptograptus dentatus.*
720. Road section beside All Saints Church, Shelve, plus adjacent field exposures. SO 3365 9901. Mytton Member (Shelve Church Beds). *Corymbograptus deflexus*; *C.* cf. *inflexus*; *Expansograptus* cf. *nitidus*; *E.* cf. *sparsus*; *Glyptograptus shelvensis.*
739. 158 m at 329° from St Michael's Church, Church Stoke. SO 2705 9413. Hagley Member. *Orthograptus calcaratus vulgatus*; *Diplograptus* cf. *foliaceus*; *Climacograptus* sp.
744. 1271 m at 287° from Methodist Chapel, Old Church Stoke. SO 2745 9525. Hagley Member. *Diplograptus leptotheca*; *Climacograptus* aff. *antiquus lineatus.*

747. Old quarry 465 m NW of Rock House. SO 2740 9603. Whittery Member. *Diplograptus foliaceus*; *Dictyonema* sp.
779. Laneside exposure 100 m S of Tankerville Mine. SO 3555 9937. Mytton Member. *Tetragraptus* cf. *bigsbyi*; didymograptid.
783. Bergam Quarry, 567 m at 5° from Methodist Chapel, Pennerley. SO 3565 9976. Mytton Member (Tankerville Flags). *Expansograptus* cf. *nitidus*; *E.* cf. *praenuntius*; *E.* cf. *suecicus*.
791. Tip heaps 120 m east of Tankerville Mine. SO 3664 9946. Mytton Member. *Isograptus* sp.
834. Road section 472 m at 110° from Hope Church. SJ 3455 0133. Hope Member. *Didymograptus pluto*.
834N. 360 m SW of Hope Rectory. SJ 3388 0125. Hope Member. *Acrograptus* cf. *acutidens*.
853A. 664 m at 69° from Stiperstones Inn. SJ 3692 0070. Mytton Member. *Expansograptus* cf. *simulans*.
905. 1268 m at 9° from All Saints Church, Shelve. SJ 3392 0025. Mytton Member. *Expansograptus* cf. *nitidus*; *E.* cf. *simulans*; *Glyptograptus dentatus*; various dendroids.
922. Hope Valley (Shropshire Sheet 47/12), not localized. Hope Member. *Pseudophyllograptus* (?) cf. *glossograptoides*.
933. 1128 m at 357° from All Saints Church, Shelve. East Roman Gravels. SJ 3348 0032. Mytton Member (Tankerville Flags). *Clonograptus* sp.; dichograptid stipes; dendroids.
946. Shale exposed in water pipeline leading to digging, north end of Todleth Hill. SO 290 950. Stapeley Member. *Amplexograptus* cf. *confertus*.
956. 1369 m at 245° from Methodist Chapel, Meadowtown. SJ 2990 0066. Rorrington Member, passage beds to Spy Wood Member. *Nemagraptus gracilis*; *Dicellograptus* cf. *exilis*; *Dicranograptus brevicaulis*; *D. rectus*; *Orthograptus uplandicus*.
957A. 200 m NE of Betton Wood Farm. SJ 3134 0255. Meadowtown Member. *Climacograptus* aff. *antiquus lineatus*.
959. In wood, 650 m SE of Lyde. SJ 3205 0106. Hope Member. *Didymograptus pluto*; *Amplexograptus* cf. *confertus*; *Glyptograptus* sp.

Lyde Stream junction. SJ 3180 0149. Weston Member. *Didymograptus murchisoni*.

Illing Collection of Hope Member. No locality. *Glossograptus* cf. *armatus*; *Climacograptus* cf. *angustatus*; *Didymograptus* cf. *stabilis*; *Acrograptus* cf. *acutidens*.

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